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THE
MINING CATALOG

FOR THE YEAR

1917

Indexed by Firms Represented, Their Branch Offices and
Agencies, and by Products

TOGETHER WITH

TREATISE AND ENGINEERING DATA COVERING
VARIOUS SUBJECTS PERTAINING
TO MINING

DEVISED, COMPILED, EDITED AND PUBLISHED
ANNUALLY BY

KEYSTONE CONSOLIDATED PUBLISHING CO., INC.

302 PENN AVENUE
PITTSBURGH, PA

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INTRODUCTION

In spite of war conditions, the MINING CATALOG makes its fourth annual appearance permeated with optimism. We believe in our country's cause and the triumph of right. Moreover, the past year has been a good one to us. It has witnessed the growth of this annual to a degree where it has become a virile factor in the coal industry. We have hundreds of expressions from mining officials sounding the praises of the MINING CATALOG; we have equally conclusive evidence from the manufacturer as to its worth to them. It has in a brief time, and much to our gratification, become invaluable to both the producer and consumer of mining equipment.

At the very inception of this enterprise, we declared our purpose to make the MINING GATALOG **even more** than a complete encyclopedia of mining appliances. It is one thing to know **where** to buy; it is another thing to know **what** to buy. The thought arose, "Why not have the MINING CATALOG serve both purposes?" a truly ambitious and far-reaching undertaking. In reality this idea obligated us to publish a text-book on coal mining as a part of the Catalog. Furthermore, it implied that in order to keep abreast of the constant improvements and innovations in mining machinery, each section would, of necessity, have to undergo a yearly revision. Acceptance would commit us to a venture in the strictly educational side of mining, which, on second thought, harmonizes entirely with the catalog section of the book—for how can the display and explanation of mining equipment be better characterized than to term it educational?

We sought the advice of the manufacturer, and the counsel of the men at the mines, and with one accord they endorsed the idea. We have, therefore, accepted these self-imposed obligations, believing that our efforts will be appreciated by the large clientage we serve, and especially by the busy mining official, who, in the interest of expediency, wishes information concentrated under one cover and made convenient for use at any and all times.

This issue, therefore, comes to you as a practical fulfillment of an idea. With the issue of 1918, we hope to present articles treating the several remaining sections, which, owing to lack of time, we were compelled to forego this year. Remember this is the **continuation of our movement** to make the MINING CATALOG **absolutely indispensable** to both the mine managing and engineering force. We are aware of many imperfections in this issue, but we believe you will agree that it is the best of our volumes. We invite your co-operation to make future issuer still better. A word of advice or criticism—whether a brick bat or a bouquet—will be appreciated.

A suggestion has come to us that in view of the educational work being carried on by local Mining Institutes and other agencies, it would fill a want is detached copies of the various sections, consisting of text, data and catalog, could be furnished in quantities and used as a basis for the instructional work carried on. Where such service can be rendered, we invite inquiries and will be glad to furnish the desired section in quantities at a nominal cost.

To the Mining Man

"Next to knowing a thing is to know where to get information about it."

This volume is dedicated to you.

It is given to you to USE.

The object of the MINING CATALOG is to give you a comprehensive digest on all classes of mining machinery and equipment. It is conveniently arranged in Sections or Subjects, so that the investigation of any subject may be pursued without coming in contact with something entirely irrelevant.

The subject of "Preparation and Loading of Coal," for instance, is covered in the Tipple Section. In addition to the condensed catalogues of the manufacturers of this class of equipment will be found engineering data, specification data, tables, formulae, charts, etc., bearing upon this particular subject.

Likewise the subjects of Development and Engineering, Mine Timbering and Building Materials, Coke Ovens, Power Plant, Lubrication, Ventilation, Hoisting and Haulage, Mine Cars, Track, Hydraulics, Mine Locomotives, Mining Machines, Electrical Supplies, Explosives, Mine Lighting, First Aid, and General Mine Supplies, are each covered in a thorough and efficient manner.

Fully ninety per cent of the manufacturers of mining machinery and equipment who are really factors in the mining industry are represented in the MINING CATALOG.

This year's book carries an increase of 40% over last year.

Every additional page of catalogue description means that you are getting a more valuable reference book. This point you should always keep in mind, and if you are looking for the catalogue of some firm that you cannot find in this book we want you to write to us, and to the firm who has missed the opportunity of subscribing to this catalog service.

The firms who have subscribed to this book want to know that you are using it. It is no more than right that you should let them know that it is valuable to you as a reference work. They want to know that their confidence has not been misplaced.

To the Manufacturers and Dealers

In publishing the MINING CATALOG we have an IDEAL constantly before us. This ideal is nearer accomplishment with this issue than ever before.

In our presentation to the mining man, you can see what the object of this volume is, and the mission we have to perform.

Since issuing our 1914, 1915 and 1916 Editions we have received over five thousand letters from mining men all over the country, telling us how valuable this book is to them in looking up different types and classes of machinery and equipment, in addition to the Engineering Data.

This leaves no doubt in our minds that we have struck the right idea.

All the operating officials of coal mines receive a vast amount of literature during the year from manufacturers. This literature comes in the shape of catalogues, bulletins, pamphlets, circulars, house-organs, etc., of all sizes, shapes and forms. A very large proportion of this literature is wasted, because it is either thrown away or filed away so carefully it cannot be located when it is needed.

Is it not much more convenient to have all the essential points of your products shown in one volume containing similar information shown by other manufacturers? Will it not save the mining man time in his office routine?

You, who have helped make this book possible, should further extend your cooperation in making the MINING CATALOG more useful to the mining man, by describing your products in such a way that it will leave no doubt in the minds of the mining fraternity as to just what their advantages are.

This will reflect favorably upon you in various ways, and at the same time will help to reduce the wanton waste in advertising.

When followed up with the information which our Directory of Mines gives you, your space in this book is bound to be productive of results. We thank you for your cooperation and patronage.

Respectfully submitted,

KEYSTONE CONSOLIDATED PUBLISHING COMPANY.
Joseph J. Vigneau, President.
E. B. Day, Vice President and General Manager.
Ralph C. Becker, Secretary.
E. N. Zern, Mining Engineer and Editor.

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Alphabetical List of Firms Catalogued, giving List of Branch Offices, Representatives and Agencies

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- Birmingham, Ala.
- Buffalo, N. Y.
- Chicago, Ill.
- Denver, Colo.
- Duluth, Minn.
- Hazleton, Pa.
- Louisville, Ky.
- New Orleans, La.
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- Pittsburgh, Pa.—H. W. Townsend, Mgr., Keenan Bldg.

Agencies:
- Birmingham, Ala.—C. B. Davis Engineering Co., Brown-Marx Bldg.
- Bluefield, W. Va.—Superior Supply Co.
- Butte, Mont.—S. P. Wright & Co.
- Denver, Colo.—Hendrie & Bolthoff Mfg. & Supply Co.
- Huntington, W. Va.—Huntington Supply & Equipment Co.
- Los Angeles, Cal.—Harron, Rickard & McCone.
- St. Louis, Mo.—Reeves & Skinner Machinery Co.
- St. Paul, Minn.—Robinson, Cary & Sands Co.
- San Francisco, Cal.—Harron, Rickard & McCone.
- Sherman, Texas—Hardwicke-Etter Co.
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- Montreal, Quebec, Can.—Peacock Bros.

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- Chicago, Ill.—Crerar, Adams & Co.
- Corry, Pa.—Climax Mfg. Co.
- Duluth, Minn.—Marshall, Wells Hdw. Co.
- Huntington, W. Va.—Banks Supply Co.
- Kalamazoo, Mich.—Kalamazoo Ry. Supply Co.
- Lima, O.—Lima Loco. Works.
- New York, N. Y.—Fox Bros. & Co.
- New York, N. Y.—Manning, Maxwell & Morre.
- New York, N. Y.—Oliver Bros. Purchasing Co.
- Philadelphia, Pa.—Standard Supply & Equip. Co.
- Pittsburgh, Pa.—Biddle Purchasing Co.
- Pittsburgh, Pa.—Frick & Lindsay Co.
- Pittsburgh, Pa.—Pittsburgh Gauge & Supply Co.
- Pittsburgh, Pa.—Standard Supply & Equip. Co.
- Pittsburgh, Pa.—Somers, Fitler & Todd Co.
- Portland, Ore.—Railway Equip. Co.
- St. Louis, Mo.—Handlan-Buck Mfg. Co.
- St. Louis, Mo.—Zelnicker Supply Co.
- San Francisco, Cal.—Eccles & Smith Co.
- Seattle, Wash.—Hofius Steel & Equip. Co.
- Seattle, Wash.—Railway Supply Co.
- Wilkes-Barre, Pa.—Vulcan Iron Wks.

Canadian Offices:
- Montreal, Can.—F. H. Hopkins & Co.
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ALLEN & GARCIA COMPANY.....90
955 McCormick Bldg., Chicago, Ill.

ALLIS-CHALMERS MANUFACTURING COMPANY 246-247-370-554
Milwaukee, Wis.

Branch Offices:
- Atlanta, Ga.—1104 Healey Bldg.
- Birmingham, Ala.—Brown-Marx Bldg.
- Boston, Mass.—50 Congress St.
- Buffalo, N. Y.—Elicott Square Bldg.
- Chicago, Ill.—Peoples Gas Bldg.
- Cincinnati, O.—First National Bank Bldg.
- Cleveland, O.—Schofield Bldg.
- Dallas, Texas.—Sumpter Bldg.
- Denver, Colo.—First National Bank Bldg.
- Detroit, Mich.—Ford Bldg.
- Duluth, Minn.—Alworth Bldg.
- El Paso, Texas.—2900 San Diego St.
- Kansas City, Mo.—Waldheim Bldg.
- Los Angeles, Cal.—Title Insurance Bldg.
- Milwaukee, Wis.—West Allis Works.
- Minneapolis, Minn. — Corn Exchange Bldg.
- New Orleans, La. — Maison Blanche Bldg.
- New York, N. Y.—50 Church St.
- Philadelphia, Pa. — 903 Pennsylvania Bldg.
- Pittsburgh, Pa.—1289 Park Bldg.
- Portland, Ore.—Lumbermen's Bldg.
- St. Louis, Mo. — Railway Exchange Bldg.
- Salt Lake City, Utah.—Kearns Bldg.
- San Francisco, Cal.—Rialto Bldg.
- Seattle, Wash.—115 Jackson St.
- Toledo, O.—Ohio Bldg.

Canadian Representatives:
- Toronto, Ont.—Canadian Allis-Chalmers, Limited.

ALLISON COUPON CO............805
Indianapolis, Ind.

AMERICAN ABRASIVE METALS CO. 514
Hudson Terminal Bldg.,
New York, N. Y.

Representatives:
- Birmingham, Ala.—General Machinery Co.
- Huntington, W. Va.—Huntington Supply & Equipment Co.
- Pittsbufgh, Pa. — Frederick North, Jenkins Arcade Bldg.

AMERICAN BLOWER CO..333-334-335
Detroit, Mich.

Branch Offices:
- Atlanta, Ga.
- Baltimore, Md.
- Boston, Mass.
- Chicago, Ill.
- Cleveland, Ohio.
- Columbus, Ohio.
- Des Moines, Iowa.
- Detroit, Mich.
- Grand Rapids, Mich.
- Indianapolis, Ind.
- Kansas City, Mo.
- New York, N. Y.
- Philadelphia, Pa.
- Pittsburgh, Pa.
- Rochester, N. Y.
- Rochester, N. Y.
- St. Louis, Mo.
- Salt Lake City, Utah.
- Seattle, Wash.

Agencies:
- Charlotte, N. C.
- Denver, Colo.
- El Paso, Texas.
- Los Angeles, Cal.
- Minneapolis, Minn.
- New Orleans, La.
- San Francisco, Cal.

AMERICAN CAR & FOUNDRY CO. 456-457
New York, N. Y.—165 Broadway.
St. Louis, Mo.—915 Olive St.

Branch Offices:
- Berwick, Pa.
- Buffalo, N. Y.—Clinton and Babcock Sts.
- Chicago, Ill.—421 Railway Exchange Bldg.
- Detroit, Mich.—Russell and Ferry.
- Huntington, W. Va.—First Ave. and 23rd St.
- Indianapolis, Ind.—1503 Kentucky Av.
- Jeffersonville, Ind.—Missouri Ave.
- Madison, Ill.
- Memphis, Tenn.
- Milton, Pa.—Arch St.
- Pittsburgh, Pa.—2221 Farmers Bank Bldg.
- St. Charles, Mo.
- Terre Haute, Ind.—10½ and Crawford Sts.
- Wilmington, Del.

AMERICAN CAST IRON PIPE CO. 588-589
Birmingham, Ala.

General Sales Office:
- Chicago, Ill. — First National Bank Bldg.

Branch Sales Offices:
- Columbus, O.—607 New Hayden Bldg.
- Dallas, Texas—1217 Praetorian Bldg.
- Kansas City, Mo.—716 Scarritt Bldg.
- Minneapolis, Minn. — 712 Plymouth Bldg.
- New York, N. Y.—1 Broadway.
- Portland, Ore.—303-305 Henry Bldg.
- San Francisco, Cal.—711 Balboa Bldg.
- Salt Lake City, Utah—324 Walker Bank Bldg.

AMERICAN MINE DOOR CO., THE 654-655
Canton, Ohio.

AMERICAN SHEET AND TIN PLATE CO. 162
Frick Bldg., Pittsburgh, Pa.

Branch Offices:
- Chicago, Ill.—W. H. Eaton, Sales Mgr., Continental and Commercial Bank Bldg.
- Cincinnati, O.—W. T. Shannon, Sales Mgr., Union Trust Bldg.
- Denver, Colo.—Edw. M. Sparhawk, Sales Mgr., First Natonal Bank Bldg.
- Detroit, Mich.—Jas. A. Smith, Jr., Sales Mgr., Dime Bank Bldg.
- New Orleans, La.—S. W. Wheelock, Sales Mgr., Maison Blanche.
- New York, N. Y.—Theo. A. Gessler, Sales Mgr., Hudson Terminal Bldg.
- Philadelphia, Pa.—Thomas W. Simpers, Sales Mgr., Widener Bldg.
- Pittsburgh, Pa.—Jos. R. Bates, Sales Mgr., Frick Bldg.
- St. Louis, Mo.—O. J. Willis, Sales Mgr., Third National Bank Bldg.

Pacific Coast Representatives:
- Los Angeles, Cal.—U. S. Steel Products Co.
- Portland, Ore.—U. S. Steel Products Co.
- San Francisco, Cal.—U. S. Steel Products Co.
- Seattle, Wash.—U. S. Steel Products Co.

Export Representatives:
- New York, N. Y.—U. S. Steel Products Co.

Works:
- Bridgeport. O.—Aetna Standard.
- Cambridge, O.—Cambridge.
- Cambridge, O.—Guernsey.
- Canton, O.—Roll and Machine.
- Canal Dover, O.—Dover.
- Chester, W. Va.—Chester.
- Cleveland, O.—Crescent.
- Elwood, Ind.—American.
- Farrell, Pa.—Farrell.
- Gary, Ind.—Gary.
- Hyde Park, Pa.—Hyde Park.
- Leechburg, Pa.—Leechburg.
- McKeesport, Pa.—W. Dewees Wood.
- Martins Ferry, O.—Laughlin.
- Monessen, Pa.—National.
- Morgantown, W. Va.—Sabraton.
- New Castle, Pa.—New Castle.
- New Castle, Pa.—Shenango.
- New Kensington, Pa.—Pennsylvania.
- New Kensington, Pa.—Pittsburgh.
- New Philadelphia, O.—New Philadelphia.
- Scottdale, Pa.—Old Meadow.
- Scottdale, Pa.—Scottdale.
- South Sharon, Pa.—Mercer.
- Vandergrift, Pa.—Vandergrift.
- Wellsville, O.—Wellsville.
- Wheeling, W. Va.—La Belle.

AMERICAN STEAM CONVEYOR CORPORATION 244
326 W. Madison St., Chicago, Ill.

Branch Office:
- New York City, N. Y.—50 E. 42nd St.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont

Agencies:
- Boston, Mass.—Colwell & McMullin, 79 Milk St.
- Buffalo, N. Y.—A. J. Abels Co., Brisbane Bldg.
- Cincinnati, O.—Henry P. Thompson, Mercantile Library Bldg.
- Cleveland, O.—Steam Equipment Mfg. Co., Leader-News Bldg.
- Detroit, Mich.—F. H. Mason, 614 Moffatt Bldg.
- Duluth, Minn.—Rich, Raley & Co., Providence Bldg.
- Milwaukee, Wis.—F. H. Dorner, Wells Bldg.
- New Orleans, La.—Walter Castenado, 1101 Hennen Bldg.
- Pittsburgh, Pa. — Steam Equipment Mfg. Co., Jenkins Arcade Bldg.
- St. Louis, Mo.—Fred Girtanner Co., Chemical Bldg.

Canadian Agencies:
- Montreal, Can.—R. E. Cleaton Co.
- Toronto, Can.—R. E. Cleaton, 105 Bond St.

AMERICAN STEAM GAUGE & VALVE MFG. CO..........................273

Camden St., Boston, Mass.

Branch Offices:
- Atlanta, Ga.
- Chicago, Ill.
- New York, N. Y.
- Pittsburgh, Pa.

AMERICAN STEAM PUMP CO......555

Battle Creek, Mich.

Branch Offices:
- Chicago, Ill.—1220 Monadnock Bldg.
- New York, N. Y.—17 Battery Place.

Sales Offices:
- Cleveland, O.—Dravo-Doyle Co.
- Indianapolis, Ind.—Dravo-Doyle Co.
- Philadelphia, Pa.—Dravo-Doyle Co.
- Pittsburgh, Pa.—Dravo-Doyle Co.

AMERICAN STEEL & WIRE CO. 400-648

208 South La Salle St., Chicago, Ill.

Sales Offices:
- Baltimore, Md.—32 South Charles St.
- Birmingham, Ala.—Brown-Marx Bldg.
- Boston, Mass.—120 Franklin St.
- Buffalo, N. Y.—337 Washington St.
- Chicago, Ill.—208 South La Salle St.
- Cincinnati, O.—Union Trust Bldg.
- Cleveland, O.—Western Reserve Bldg.
- Denver, Colo. — First National Bank Bldg.
- Detroit, Mich.—Foot of First St.
- New York, N. Y.—30 Church St.
- Oklahoma City, Okla.—State National Bank Bldg.
- Philadelphia, Pa.—Widener Bldg.
- Pittsburgh, Pa.—Frick Bldg.
- St. Louis, Mo.—Third National Bank Bldg.
- St. Paul-Minneapolis, Minn. — Pioneer Bldg., St. Paul.
- Salt Lake City, Utah.—Walker Bank Bldg.
- Wilkes-Barre, Pa.—Miners Bank Bldg.
- Worcester, Mass.—94 Grove St.

Export Representative:
- United States Steel Products Co., 30 Church St., New York.

Pacific Coast Representatives:
- Los Angeles, Cal.—U. S. Steel Products Co.
- Portland, Ore.—U. S. Steel Products Co.
- San Francisco, Cal.—U. S. Steel Products Co.
- Seattle, Wash.—U. S. Steel Products Co.

AMERICAN WELLS WORKS, THE 552-553

Aurora, Ill.

Agencies:
- Birmingham, Ala.—Keiser-Geismer Engineering Co.
- Dallas, Tex.—American Well Works.
- Denver, Colo.—M. J. O'Fallon Supply Co.
- Kansas City, Mo.—J. H. Dousman, Reliance Bldg.
- Joplin, Mo.—McNeal Machinery Co.
- Lincoln, Nebr.—A. B. Price.
- Los Angeles, Cal.—American Pump Co.
- New Mexico, N. M.—Sperry & Lukins, Artesia.
- New York, N. Y.—S. B. Whinery, 95 Liberty St.
- Philadelphia, Pa. — Sciple-Gochenaur Mfg. Co., 631 Arch St.
- Pittsburgh, Pa.—Reineke-Wagner Pump & Supply Co.
- St. Paul, Minn.—R. B. Whitacre & Co.
- St. Louis, Mo.—Farrar Pump & Machinery Co.
- Salt Lake City, Utah. — Green Machinery & Mfg. Co.
- San Francisco, Cal.—California Hydraulic Engineering & Supply Co.

Canadian Agencies:
- Calgary, Alberta., Canada — Gorman, Clancy & Gringley, Ltd.
- Chatham, Ontario, Canada—Canadian-American Pump & Well Machinery Co., Ltd.
- Edmonton, Alberta, Canada—Gorman, Clancy & Grindley, Ltd.
- Montreal, Canada—R. H. Buchanan & Co.

ARMSTRONG CORK & INSULATION CO................259

Pittsburgh, Pa.

Branch Offices:
- Atlanta, Ga.—1202 Candler Bldg.
- Boston, Mass.—84 North St.
- Chicago, Ill.—320 West Randolph St.
- Cincinnati, O.—1608 First National Bank Bldg.
- Cleveland, O. — 404 American Trust Bldg.
- Dallas, Texas.—Busch Bldg.
- Detroit, Mich.—1101 Chamber of Commerce Bldg.
- Indianapolis, Ind.—415 John Murphy Bldg.
- Kansas City, Mo.—529 Reserve Bank Bldg.
- Minneapolis, Minn. — 937 Plymouth Bldg.
- New York, N. Y.—50 Church St.
- Rochester, N. Y.—808 Powers Bldg.
- St. Louis, Mo.—Third and Elm Sts.

Agencies:
- Baltimore, Md.—John R. Livezey, 9-11 Commerce St.
- Great Falls, Mont.—D. E. Fryer & Co., 321 Ford Bldg.
- Los Angeles, Cal.—C. M. Gay & Son, 335 Towne Ave.
- New Orleans, La.—H. T. Steffee, 605-7 Baronne St.
- Philadelphia, Pa.—John R. Livezey, 1933 Market St.
- Portland, Ore.—Gillon-Chambers Co., 66 North Front St.
- San Francisco, Cal.—M. V. Van Fleet, Sharon Bldg., 120 Jessie St.
- Seattle, Wash.—D. E. Fryer & Co., 305 Lumber Exchange Bldg.
- Spokane, Wash.—D. E. Fryer & Co. 604 Paulsen Bldg.
- Tacoma, Wash.—D. E. Fryer & Co., National Realty Bldg.

Canadian Offices:
- Montreal, Que., Can.—Armstrong Cork & Insulation Co., Ltd., 902 McGill Bldg.
- Toronto, Ont., Can.—Armstrong Cork & Insulation Co., Ltd., 214 King St. East.

ASHTON VALVE CO., THE.........274

161-179 First St., Cambridge "C,"
Boston, Mass.

Branch Offices:
- Chicago, Ill.—608 S. Dearborn St.
- New York, N. .—128 Liberty St.
- San Francisco, Cal.—503 Mission St.

Agents:
- Atlanta, Ga.—Earl F. Scott, M. E., Candler Bldg.
- Baltimore, Md.—Frank R. Small, 619 Equitable Bldg.
- Birmingham, Ala.—J. I. Blount & Co., Brown-Marx Bldg.
- Buffalo, N. Y.—J. H. Ruckel & Son, 81 Main St.
- Cincinnati, O.—Doermann-Roehrer Co., 325 East Third St.
- Cleveland, O.—Tomlinson Steam Specialty Co., Wade Building.
- Dallas, Texas—Dallas Mill Supply Co., 713 Elm St.
- Detroit, Mich. — Coon-DeVisser Co., Ford Building.
- El Paso, Texas—Geo. S. Thomson, 406 San Francisco St.
- Minneapolis, Minn.—L. E. Pollard Co., 505 Metropolitan Bank Building.
- New Orleans, La.—A. M. Lockett & Co., Ltd., 533 Baronne St.
- Philadelphia, Pa.—Schade Valve Mfg. Co., 2528 North American St.
- Pittsburgh, Pa.—James Bonar & Co., Park Building.
- Rochester, N. Y.—Howe & Bassett, 23 Stillson St.
- St. Louis, Mo.—Defender Automatic Regulator Co., 507 Oriel Building.
- San Antonio, Texas—Higgins & Co., 212 Losoya St.
- Seattle, Wash.—Steam Supply & Rubber Co., 79 Washington Ave.

Canadian Agents:
- Montreal, Quebec, Canada — Mason Regulator & Eng. Co., Ltd., 380 St. James St.
- Toronto, Ont.—Mason Regulator & Eng. Co., Ltd., 311 Kent Building.

ATLANTIC REFINING COMPANY, THE 299

3144 Passyunk Ave., Philadelphia, Pa.

Branch Offices:
- Allentown, Pa.
- Altoona, Pa.
- Bellefonte, Pa.
- Bethlehem, Pa.
- Bloomsburg, Pa.
- Butler, Pa.
- Carbondale, Pa.
- Chambersburg, Pa.
- Chester, Pa.
- Clearfield, Pa.
- Coatesville, Pa.
- Connellsville, Pa.
- Danville, Pa.
- Dubois, Pa.
- Easton, Pa.
- Erie, Pa.
- Greensburg, Pa.
- Harrisburg, Pa.
- Hazleton, Pa.
- Huntingdon, Pa.
- Indiana, Pa.
- Johnstown, Pa.
- Kittanning, Pa.
- Lancaster, Pa.
- Latrobe, Pa.
- Lebanon, Pa.
- Lock Haven, Pa.
- McKeesport, Pa.
- Meadville, Pa.
- Mt. Pleasant, Pa.
- New Brighton, Pa.
- New Castle, Pa.
- New Kensington, Pa.
- Norristown, Pa.
- Oil City, Pa.
- Philadelphia, Pa.
- Philipsburg, Pa.
- Pittsburgh, Pa.
- Pittston, Pa.
- Pottstown, Pa.
- Pottsville, Pa.
- Punxsutawney, Pa.
- Reading, Pa.
- Ridgway, Pa.
- Scranton, Pa.
- Shamokin, Pa.
- Sharon, Pa.
- Shenandoah, Pa.
- Somerset, Pa.
- Spangler, Pa.
- Sunbury, Pa.
- Titusville, Pa.
- Uniontown, Pa.
- Warren, Pa.
- Washington, Pa.
- Waynesburg, Pa.
- Wellsboro, Pa.
- West Chester, Pa.
- Wilkes-Barre, Pa.
- Williamsport, Pa.
- Wilmington, Del.
- York, Pa.

ATLAS POWDER CO...........732-733

Wilmington, Del.

Branch Offices:
- Allentown, Pa.—Hunsicker Bldg.
- Birmingham, Ala. — 724 Brown-Marx Bldg.
- Boston, Mass.—185 Devonshire St.
- Chicago, Ill.—Room 890 Continental & Commercial Bank Bldg., 208 S. La Salle St.
- Houghton, Mich.—Masonic Bldg.
- Joplin, Mo.—Cosgrove Bldg.
- Kansas City, Kan.—520 R. A. Long Bldg.
- Knoxville, Tenn. — Holston National Bank Bldg.
- McAlester, Okla. — Knights Templar Bldg., 122½ E. Grand Ave.
- Nashville, Tenn.—Stahlman Bldg.
- New Orleans, La.—1409 Whitney Central National Bank Bldg.
- New York, N. Y.—120 Broadway.
- Philadelphia, Pa.—813 Harrison Bldg.
- Pittsburg, Kan.—719 North Broadway.
- Pittsburgh, Pa.—Oliver Bldg.
- Pottsville, Pa.—Thompson Bldg.
- St. Louis, Mo.—1401 Wright Bldg.
- Wilkes-Barre, Pa.—Peoples Bank Bldg.

AUSTIN POWDER CO..............734

1229 Rockefeller Bldg., Cleveland, O.

Branch Offices:
- Chicago, Ill. — Steger Bldg., 28 East Jackson Blvd.
- Detroit, Mich.—511 Owen Bldg.
- St. Louis, Mo.—1548 Pierce Bldg.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont.

AUTOMATIC RECLOSING CIRCUIT BREAKER CO....................664
Columbus, Ohio.

Agents:
- Birmingham, Ala. — McClary-Jemison Machinery Co.
- Bluefield, W. Va.—Superior Supply Co.
- Chicago, Ill.—Minerallac Electric Co., 1043-45 Washington Blvd.
- Cleveland, Ohio—Walter P. Ambos Co., 983 The Arcade.
- Detroit, Mich.—Louis J. Kaiser, 146 Park Blvd.
- Hazard, Ky.—Paramount Electric Service Co.
- Knoxville, Tenn.—Tennessee Mill & Mine Supply Co.
- Milwaukee, Wis.—T. Weiss, 1420 Majestic Bldg.
- New York, N. Y.—Jos. B. Noros, 50 Church St.
- Philadelphia, Pa.—Wm. Miller Tompkins, 4813 Haversford Ave.
- Pittsburgh, Pa.—Iron City Electric Co.
- Pittsburgh, Pa.—Railway & Industrial Engineering Co., Peoples Bank Bldg.
- Salt Lake City, Utah—Ambler, Ott & Riter, Kearns Bldg.

B

BACHARACH INDUSTRIAL INSTRUMENT COMPANY 350
422 First Ave., Pittsburgh, Pa.

BALDWIN LOCOMOTIVE WORKS, THE 500
Philadelphia, Pa.

Representatives:
- Chicago, Ill. — Charles Riddell, 627 Railway Exchange.
- New York, N. Y.—F. W. Weston, 120 Broadway.
- Portland, Ore.—A. Wm. Hinger, 512 Northwestern Bank Bldg.
- Richmond, Va.—George F. Jones, 407 Travelers Bldg.
- San Francisco, Cal.—Williams, Dimond & Co., 310 Sansome St.
- St. Louis, Mo.—C. H. Peterson, 1210 Boatmen's Bank Bldg.

BALL ENGINE COMPANY.........255
Erie, Pa.

Branch Offices:
- Boston, Mass.—Power Equipment Co., 131 State St.
- Chicago, Ill.—W. A. Kreider, Monadnock Bldg.
- Cincinnati, O.—The Ward Equipment Co., 628 Union Trust Bldg.
- Cleveland, O.—Dravo-Doyle Co., Citizens Bldg.
- Dallas, Texas — Smith & Whitney, Southwestern Life Bldg.
- Detroit, Mich. — The Coon-DeVisser Co., Ford Bldg.
- Minneapolis, Minn.—Stacy-Bates Co., 815 McKnight Bldg.
- New York City, N. Y.—L. Copleston, 39 Cortlandt St.
- Philadelphia, Pa.—Ball Engine Co., 1001 Commercial Trust Bldg.
- Pittsburgh, Pa.—Dravo-Doyle Co., Diamond Bank Bldg.
- St. Louis, Mo.—Baumes-McDevitt Machinery Co., Railway Exch. Bldg.

BALTIMORE ROOFING & ASBESTOS MANUFACTURING CO............179
Asbestos, Maryland.

Branch Offices:
- Indianapolis, Ind.—205 East Ohio St.
- New York, N. Y.—Fifth Avenue Bldg.

Agencies:
- Cleveland, O.—Ohio Roofing & Asbestos Co., 1525 Columbus Road.
- Oil City, Pa.—Pennsylvania Roofing & Asbestos Co.

BARRETT COMPANY, THE........164
17 Battery Place, New York, N. Y.

Branch Offices:
- Birmingham, Ala.
- Boston, Mass.
- Chicago, Ill.
- Cincinnati, O.
- Cleveland, O.
- Duluth, Minn.
- Kansas City, Mo.
- Louisville, Ky.
- Minneapolis, Minn.
- Nashville, Tenn.
- New Orleans, La.
- Philadelphia, Pa.
- Pittsburgh, Pa.
- St. Louis, Mo.
- Salt Lake City, Utah.
- Seattle, Wash.

Canadian Representatives:
- Montreal—Paterson Mfg. Co., Limited.
- Toronto—Paterson Mfg. Co., Limited.
- Vancouver—Paterson Mfg. Co., Limited.
- Winnipeg—Paterson Mfg. Co., Limited.
- Halifax, N. S.—Carritte-Paterson Mfg. Co., Limited.
- St. John, N. B.—Carritte-Paterson Mfg. Co., Limited.
- Sydney, N. S.—Carritte-Paterson Mfg. Co., Limited.

BEAUDRY & COMPANY............702
141 Milk St., Boston, Mass.

Agencies:
- Chicago, Ill.—The E. L. Essley Machinery Co.
- Kansas City, Mo.—The English Tool & Supply Co.
- Los Angeles, Cal.—Eccles & Smith Co.
- Milwaukee, Wis.—The E. L. Essley Machinery Co.
- New Orleans, La.—C. T. Patterson & Co.
- Philadelphia, Pa.—Sherritt & Stoer Co.
- Pittsburgh, Pa.—Brown & Zortman Machienry Co.
- Portland, Ore.—Eccles & Smith Co.
- San Francisco, Cal.—Eccles & Smith Co.
- Seattle, Wash.—Hallidie Machinery Co., Inc.

BECKWITH MACHINERY CO......690
108-110 W. Park Way, N. S., Pittsburgh, Pa.

BEMIS BRO. BAG CO..............346
St. Louis, Mo.

Branch Offices:
- Boston, Mass.
- Buffalo, N. Y.
- Chicago, Ill.
- Dallas, Texas.
- Denver, Colo.
- Detroit, Mich.
- Houston, Texas.
- Indianapolis, Ind.
- Kansas City, Mo.
- Los Angeles, Cal.
- Memphis, Tenn.
- Minneapolis, Minn.
- New Orleans, La.
- New York, N. Y.
- Omaha, Neb.
- San Francisco, Cal.
- St. Louis, Mo.
- Salt Lake City, Utah.
- Seattle, Wash.
- Wichita, Kan.
- Winnipeg, Canada.

Agencies:
- Buffalo, N. Y.—Buffalo Forge Co.
- Butte, Mont.—Anacvonda Copper Mining Co.
- Cleveland, Ohio—Wm. Pattison Supply Co.
- Columbus, Ohio—Jeffrey Mfg. Co.
- Denver, Colo.—Hendrie & Bolthoff M. & S. Co.
- Detroit, Mich.—American Blower Co.
- Duluth, Minn.—P. E. Meagher, 409 W. Michigan St.
- Los Angeles, Cal.—F. F. Foster Co., Inc.
- Minneapolis, Minn.—Hanks-Price Co.
- New York, N. Y.—G. Wallace Browne, Tribune Bldg.
- Philadelphia, Pa.—Pierce Co., 502 N. 19th St.
- Phoenix, Ariz.—Pratt Gilbert Co.
- Pittsburgh, Pa.—Colonial Supply Co.
- Pittsburgh, Pa.—Burson Supply Co.
- Salt Lake City, Utah—A. Leschen & Sons Rope Co.
- Seattle, Wash.—E. P. Jamison, 1810 L. C. Smith Bldg.
- Terre Haute, Ind.—Smith Equipment Co.

BERGER, C. L., & SONS.............73
37 Williams St., Boston, Mass.

BILLINGS-CHAPIN COMPANY, THE 165
Cleveland, Ohio.

Branch Offices:
- Boston, Mass.—146 High St.
- New York, N. Y.—438 Pearl St.

BORDEN COMPANY, THE..........710
Warren, Ohio.

Branch Offices:
- Chicago, Ill.—Charles A. Green, 1310 Winona Ave.
- New York, N. Y.—G. W. Warner, 86 Warren St.

Canadian Office:
- Toronto, Ont., Canada—Borden-Canadian Co., Mr. B. T. Borden, Mgr.

BRODERICK & BASCOM ROPE CO..........................401
St. Louis, Mo.
(Factory, South Seattle, Wash.)

Branch Office:
- New York, N. Y.—76 Warren St.

BROWNELL COMPANY, THE......225
Dayton, O.

Branch Offices:
- Chicago, Ill.—925 Monadnock Bldg.
- Cincinnati, O.—Queen City Supply Co.
- Cleveland, O. — E. P. Bates, 409 Superior St.
- Columbus, O.—Neff & Ancher.
- Dallas, Texas. — Briggs-Weaver Machine Co.
- Denver, Colo.—M. J. O'Fallon Supply Co.
- Evansville, Ind. — Evansville Supply Co.
- Kansas City, Mo.—Merkle Machinery Co.
- New Orleans, La.—A. Baldwin & Co.
- New York, N. Y.—L. R. Merritt & Co., 52 Vanderbilt Ave.
- Norfolk, Va.—Porter & Moore Co.
- Owensboro, Ky.—Wright Machine Co.
- Pittsburgh, Pa.—B. S. Rederer, 504 Arrott Bldg.
- Richmond, Va.—Sydnor Pump & Well Co.
- St. Louis, Mo.—401 Bank of Commerce Bldg.
- St. Paul, Minn.—R. B. Whitacre & Co.
- Salt Lake City, Utah. — Salt Lake Hardware Co.
- Savannah, Ga.—Georgia Supply Co.
- San Antonio, Tex.—San Antonio Machine & Supply Co.
- San Francisco, Cal.—General Machinery & Supply Co.
- Seattle, Wash.—Puget Sound Machinery Depot.
- Sidney, O.—Rhinehardt-Smith.
- Springfield, Mo.—United Iron Works Co.
- Terre Haute, Ind.—Terre Haute Boiler Works Co.
- Toledo, O. — Shaw-Kendall Engineering Co.
- Tulsa, Okla.—J. J. Keim.
- Wilmington, N. C.—Wilmington Iron Works.

BUCKEYE ROLLING MILL CO., THE 423
Steubenville, O.

Branch Offices:
- Chicago, Ill. — Wilmer Wickersham, 1850 Peoples Gas Bldg.
- Cleveland, O.—The Hamill-Hickox Co., Hickox Bldg.
- Kansas City, Mo.—R. A. Long Bldg.
- New York, N. Y.—Hudson Terminal Bldg., 30 Church St.
- St. Louis, Mo.—C. E. Hutchinson, Suite 913, Federal Reserve Bank Bldg.

BUETTNER & SHELBURNE MACHINE CO. 618-619
South Third St., Terre Haute, Ind.

Agent:
- Pittsburgh, Pa.—J. L. Goss, 1663 Jancey St.

BUFF & BUFF MFG. CO.............74
Boston, Mass.

Branch Offices:
- Chicago, Ill.—231 North Fifth Ave.
- New York, N. Y.—50 Church St.

Agents:
- Denver, Colo. — J. S. Lallie Inst. & Supply Co.
- Duluth, Minn.—J. S. Ray & Co.
- Houston, Tex. — Texas Blue Print & Supply Co.
- Los Angeles, Cal.—Adolf Frese Optical Co.
- New Orleans, La.—Kokosky & Co.
- Pittsburgh, Pa.—B. K. Elliott Co.
- San Francisco, Cal.—Frederick F Post Co.
- Washington, D. C.—Ward & Co.

Canadian Agent:
- Montreal, Can.—Hughes-Owens Co.

BUFFALO FOUNDRY & MACHINE CO. 703
Buffalo, N. Y.

Branch Office:
- New York, N. Y.—17 Battery Place.

Representatives:
- Chicago, Ill.—Jos. T. Ryerson & Son.
- San Francisco, Cal. — F. O. Stallman Supply Co.

BURSON SUPPLY CO...............783
242 First Ave., Pittsburgh, Pa.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont.

BYERS, A. M., COMPANY...........590
Pittsburgh, Pa.
Branch Offices:
Boston, Mass.—11 Sleeper St.
Chicago, Ill.—720 Fulton St.
Houston, Texas—1212 Carter Bldg.
Los Angeles, Cal.—504 Laughlin Bldg.
New York, N. Y.—23 Sullivan St.

C

CABOT, SAMUEL, INC..............166
141 Milk St., Boston, Mass.
Branch Offices:
Chicago, Ill.—24 West Kinzie St.
New York, N. Y.—1133 Broadway.

CALDWELL, W. E., CO., INC.........272
Louisville, Ky.

CALEBAUGH SELF-LUBRICATING CARBON CO. 668
1503 Columbia Ave., Philadelphia, Pa.

CAMERON, A. S., STEAM PUMP WORKS 556-557
11 Broadway, New York, N. Y.
Branch Offices:
Birmingham, Ala.—H. M. Perry, Mgr., American Trust Bldg.
Chicago, Ill.—M. P. Frutchey, Mgr., Peoples Gas Bldg.
Cleveland, O.—W. A. Armstrong, Mgr., Williamson Bldg.
Duluth, Minn.—S. N. Hill, Mgr., Providence Bldg.
Knoxville, Tenn. — L. F. Thompson, Mgr., Holston National Bank Bldg.
Los Angeles, Cal. — W. Blackburn, Mgr., 1036 Union Oil Bldg.
Houghton, Mich.—Thomas F. Lynch, Mgr., Citizens National Bank Bldg.
Philadelphia, Pa.—Phil. Weiss, Mgr., Commercial Trust Bldg.
Pittsburgh, Pa.—W. F. Gillies, Farmers Bank Bldg.
St. Louis, Mo.—D. M. Armstead, Mgr., 300 North Broadway.
Salt Lake City, Utah—J. B. Mossman, Mgr., 212 Dooly Block.
San Francisco, Cal.—H. L. Terwilliger, Mgr., Rialto Bldg.
Seattle, Wash.—R. W. Douglass, Mgr., Colman Bldg.
Domestic Agents:
Boston, Mass. — Ingersoll-Sergeant Drill Co., R. K. Swift, Mgr., 32 Oliver St.
Butte, Mont.—Ingersoll-Rand Co., R. W. Rusterholz, Mgr., 100 E. Broadway.
Denver, Colo. — Hendrie & Bolthoff
El Paso, Tex.—Ingersoll-Rand Co., J. D. Foster, Genl. Mgr., 121 San Francisco St.
Mexico City, Mex.—Cadona No. 2.
New Orleans, La. — Hibernia Bank Bldg.
Washington, D. C.—Home Life Bldg.
Canadian Agents:
Montreal, Que., Can.—Canadian Ingersoll-Rand Co., Ltd., E. W. Gillman, V. Pres.

CANCOS MANUFACTURING COMPANY 285
Philadelphia, Pa.
Agencies:
Baltimore, Md.—E. A. Nicoll, 34 Franklin Bldg.
Boston, Mass.—J. J. Sullivan, 88 Purchase St.
Cincinnati, O.—E. A. Kinsey Co.
Los Angeles, Cal.—Los Angeles Rubber Co., 122 East Third St.

CAREY, PHILIP, CO., THE........180
Lockland, Cincinnati, Ohio.
Branch Offices, Representatives and Agencies:
Atlanta, Ga.—R. O. Campbell Coal Co., Trust Company of Georgia Bldg.
Baltimore, Md.—Philip Carey Co., 41-43 So. Gay St.
Birmingham, Ala.—Young & Vann Supply Co., 1725-31 First Ave.
Boston, Mass.—Philip Carey Co., West Second and Granite Sts.
Buffalo, N. Y.—The Carey Co., 43-45 Pearl St.
Charlotte, N. C.—Charlotte Supply Co., 20-22 East Fourth St.
Chattanooga, Tenn. — James Supply Co., 1104-1112 Market St.
Chicago, Ill.—Western Roofing & Supply Co., 3611 Loomis Place.
Cincinnati, O.—Breese Bros. Co., 1606 Reading Road.
Cleveland, O.—The Carey Co., 1398-1400 W Ninth St., N. W.
Dallas, Texas—Texas Glass & Paint Co., Corner Pearl St. and Pacific Ave.
Denver, Colo.—Philip Carey Co., 433 Commonwealth Bldg.
Detroit, Mich.—The Carey Co., 15-17 Pefferson St.
El Paso, Texas—Sheehan-Hackley & Co., 1901 Texas Ave.
Havana, Cuba—Kelmah Co., P. O. Box 658.
Jacksonville, Fla.—Cameron & Barkley Co., 338-342 East Bay St.
Kansas City, Mo.—Philip Carey Co., 2008 McGee St.
Knoxville, Tenn.—W. W. Woodruff Hdwe. Co., 424 Gay St.
Little Rock, Ark.—Fischer Lime & Cement Co., 1115-1121 East Second St.
Los Angeles, Cal.—Warren & Bailey Mfg. Co., 359 North Main St.
Louisville, Ky.—R. B. Tyler Co., 114 South Fourth St.
Memphis, Tenn.—Fischer Lime & Cement Co., 269-289 Walnut St.
Minneapolis, Minn.—W. S. Nott Co., corner Second and Third Sts.
Montreal, Que.—Wm. Rutherford & Sons Co., Ltd., 425 Atwater Ave.
Nashville, Tenn.—Philip Carey Co., 210-212 South Second St.
New Orleans, La.—Woodward, Wight & Co., Ltd., Howard Ave. and Constance St.
New York, N. Y.—Philip Carey Co., 114 Liberty St.
New York, N. Y.—Richard Kelly, Inc., (Export Dept.), 114 Liberty St.
Oklahoma City, Okla.—A. M. DeBolt, 2 West Reno St.
Omaha, Neb.—Sunderland Machinery & Supply Co., 1006-08-10 Douglas Ave.
Philadelphia, Pa.—Philip Carey Co., S. E. Cor. 13th and Hamilton Sts.
Pittsburgh, Pa. — Philip Carey Co., 1139-1141 Penn Ave.
Portland, Ore.—Munnell & Sherrill, 40 First St.
St. Louis, Mo.—Philip Carey Co., 1414 N. Broadway.
San Antonio, Texas—Turner Rfg. & Supply Co., Dawson St. and S. P. Tracks.
San Francisco, Cal.—Western Asbestos & Magnesia Co., 25-27 Park St., So.
Seattle, Wash.—Philip Carey Co., 617 Western Ave.
Spokane, Wash.—Nott-Atwater Co., 157 S. Monroe St.
Tampa, Fla.—Cameron & Barkley Co., South Franklin St.
Toronto, Ont.—Philip Carey Co., 77 Front St.
Washington, D. C.—Asbestos Covering Co., 916-918 D St., N. W.
Wheeling, W. Va.—Philip Carey Co., 1505 Main St.

CARLIN, JOHN H., MACHINE CO..691
N. S., Pittsburgh, Pa.

CARNEGIE STEEL CO.............157
Carnegie Bldg., Pittsburgh, Pa.
Branch Offices:
Birmingham, Ala.—Brown-Marx Bldg.
Boston, Mass.—120 Franklin St.
Buffalo, N. Y.—Marine National Bank Bldg.
Chicago, Ill.—208 S. La Salle St.
Cincinnati, O.—Union Trust Bldg.
Cleveland, O.—Rockefeller Bldg.
Denver, Colo.—First Natl. Bank Bldg.
Detroit, Mich.—Ford Bldg.
New Orleans, La.—Maison Blanche.
New York, N. Y.—30 Church St.
Philadelphia, Pa.—Widener Bldg.
St. Louis, Mo.—Third Natl. Bank Bldg.
St. Paul, Minn.—Pioneer Bldg.
Representatives:
George Baker, Manager of Sales, Chicago, Ill.
James B. Bonner, Manager of Sales, Philadelphia, Pa.
H. P. Bope, Vice-President and General Manager of Sales, Pittsburgh, Pa.
Chas. C. Cluff, Manager of Sales, New York, N. Y.
,W. G. Clyde, Assistant General Manager of Sales, Pittsburgh, Pa.
D. R. Cotton, Manager of Sales, St. Paul, Minn.
F. C. Deming, Manager of Sales, Buffalo, N. Y.
Albert M. Harper, Manager of Sales, Buffalo, N. Y.
W. S. Locke, Manager of Sales, Boston, Mass.
E. S. Mills, Special Sales Agent, Chicago, Ill.
James R. Mills, Manager of Sales, Cleveland, Ohio.
W. P. Siebert, Assistant General Manager of Sales, Pittsburgh, Pa.
Edw. M. Sparhawk, Manager of Sales, Denver, Colo.
Frank E. Spencer, Manager of Sales, Detroit, Mich.
W. B. Weston, Manager of Sales, St. Louis, Mo.
Stillman W. Wheelock, Manager of Sales, New Orleans, La.
Willard Wilson, Manager of Sales, Birmingham, Ala.
John E. Woods, Manager of Sales, Cincinnati, Ohio.

CATARACT REFINING & MANUFACTURING CO. 301
Marine Natl. Bank Bldg.,
Buffalo, N. Y.
Plants:
Buffalo, N. Y., and Chicago, Ill.
Warehouses:
Boston, Mass.
Buffalo, N. Y.
Detroit, Mich.
Chicago, Ill.
New York, N. Y.
San Francisco, Cal.
Toronto, Ont., Can.
Branch Offices:
Chicago, Ill.—327 S. La Salle St.
New York, N. Y.—17 Battery Place.

CEMENT-GUN COMPANY, INC......72
Allentown, Pa.
Agencies:
Chicago, Ill.—E. R. Ayers, 1414 Fisher Bldg.
New York, N. Y.—Cement-Gun Co., Inc., 30 Church St.
Pittsburgh, Pa.—Beckwith Machinery Co.
Salt Lake City, Utah—John A. Traylor, Newhouse Bldg.
Seattle, Wash. — Taylor Engineering Co., 538 Central Bldg.
Canadian Agencies:
Vancouver, B. C.—Taylor Engineering Co.

CEMENT PRODUCTS COMPANY...191
Wilmington, N. C.
Branch Offices:
Atlanta, Ga.—East Point.
Charleston, W. Va.—Union Trust Bldg.
Philadelphia, Pa.—328 Chestnut St.
Pittsburgh, Pa.—Oliver Bldg.

CERTAIN-TEED PRODUCTS CORPORATION 181
Boatmen's Bank Bldg.,
St. Louis, Mo.
Branch Offices:
Atlanta, Ga.—H. J. Ouellette, .Healy Bldg.
Boston, Mass.—R. S. Chase, West Second and Granite Sts.
Buffalo, N. Y.—F. E. Smith, Ellicott Square.
Chicago, Ill.—W. A. Murphy, Continental & Commercial Bank Bldg.
Cincinnati, O.—R. T. Shaw, Union Central Bldg.
Cleveland, Ohio—Geo. M. Piney, Jr., Leader-News Bldg.
Des Moines, Iowa—C. S. Collins, Hubbel Bldg.
Detroit, Mich.—E. C. Richardson, Dime Savings Bank Bldg.
Duluth, Minn.—J. R. Pflueger, Sellwood Bldg.
Grand Rapids, Mich.—E. F. Conely, Grand Rapids Savings Bldg.
Houston, Texas—W. M. Walsh, Walnut and Wood Sts.
Indianapolis, Ind.—G. R. Frisbie, Merchants National Bank Bldg.
Kansas City, Mo.—C. J. Stovel, R. A. Long Bldg.
Los Angeles, Cal.—Curtis C. Noel, Citizens National Bank Bldg.
Milwaukee, Wis.—E. J. W. Walker, First Natoinal Bank Bldg.
Minneapolis, Minn.—N. B. Paulson, Plymouth Bldg.
Nashville, Tenn.—N. B. Jinnett, Jr., 105 Broadway.
New Orleans, La.—E. J. Reinger, 417 Magazine St.
New York, N. Y.—W. M. Taylor, Woolworth Bldg.
Philadelphia, Pa.—H. P. Stewart, New Stock Exchange Bldg.
Pittsburgh, Pa.—O. W. Sheets, Oliver Bldg.
Richmond, Va.—W. F. Barnes, 602 N. Seventeenth St.
St. Louis, Mo.—H. N. Saylor, Jr., Boatmen's Bank Bldg.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont

Salt Lake City, Utah—Harold Graham, Walker Bank Bldg.
San Francisco, Cal.—John W. Geary, Insurance Exchange Bldg.
Seatle. Wash.—Alan P. Cline, L. C. Smith Bldg.

CHANDLER & TAYLOR CO.........226
Indianapolis, Ind.
Branch Offices:
Chicago. Ill.—C. S. Buell, Mgr., 1641 Monadnock Bldg.
New York. N. Y.—J. Kilshaw, Mgr., 39 Cortlandt St.
Agencies:
Bloomington, Ill. — Keiser-Van Leer Co.
Danville, Ill.—Robt. Holmes & Bros.
Denver, Colo.—Hendrie & Bolthoff Co.
East Liverpool, O.—Patterson Foundry & Machine Co.
El Paso, Tex. — El Paso Foundry & Machine Co.
Jacksonville, Fla.—Farquhar Machinery Co.
Joplin, Mo.—McNeal Machinery Co.
Little Rock, Ark.—C. E. Rosenbaum Machinery Co.
Memphis, Tenn.—Chickaway Machine & Foundry Co.
New Orleans, La.—A. M. Locket & Co.
Ocalo, Fla.—McIver & MacKay.
Owensboro, Ky.—Wright Machine Co.
Portland, Ore.—W. L. Blake & Co.
Philadelphia, Pa.—National Supply & Equipment Co.
Salt Lake City, Utah.—Galigher Machinery Co.
San Francisco, Cal.—H. F. Lyons Co.
Seattle, Wash.—Washington Machinery & Supply Co.
Shreveport. La. — W. K. Henderson Iron Works & Supply Co.
Van Wert, O.—Spayd Bros.
Waco, Tex.—D. June Machinery Co.
Washington, D. C.—L. C. Holmes, Ouray Bldg.

CHEESMAN & ELLIOT...........167
100 Williams St., New York, N. Y.
Agents:
Brooklyn, N. Y.—Norman Elliot, 639 Kent Ave.
Kirkville, N. Y.—J. Frank Case.
Lancaster, Pa.—Henry M. Schroeder.
Punxsutawney, Pa.—J. A. Whiteman.
Williamsport, Pa.—B. T. Epler, East Street.

CHERRY TREE MACHINE CO.....371
Cherry Tree, Pa.

CHILDS, H. L., & CO., INC..........784
Pittsburgh, Pa.

CINCINNATI FROG & SWITCH CO..434
Cincinnati, Ohio.

CLING-SURFACE COMPANY 294
Buffalo, N. Y.
Branch Offices:
Boston, Mass.—170 Summer St.
Chicago, Ill.—301 Sharples Bldg.
New York, N. Y.—39 Cortland St.
St. Louis, Mo.—915 Security Bldg.

CLINTON SWITCH CO.............435
Clinton, Ind.

CLOW, JAMES B., & SONS......588-589
Chicago, Ill.
Eastern Office:
New York, N. Y.—17 Battery Place.

COLONIAL SUPPLY CO. 785-786-787-796
412-414 First Ave., Pittsburgh, Pa.
Beginning May 1, 1918, 217 Water St. and 216 First Ave., Pittsburgh, Pa.
Branch Offices:
Cleveland, O.—872 Rockefeller Bldg.
New York, N. Y.—29 Cortlandt St.

COMBUSTION ENGINEERING CORPORATION 236-237
11 Broadway, New York, N. Y.
Branch Offices:
Atlanta, Ga.
Birmingham, Ala. — Deiser-Geismer Engineering Co.
Boston, Mass.—Schumaker-Santry Co.
Chicago, Ill.—Fisher Bldg.
Hazleton, Pa.—Market Bank Bldg.
Minenapolis, Minn.—L. E. Pollard Co.
Philadelphia, Pa.—718 Lincoln Bldg.
Pittsburgh, Pa.—George J. Hagan, 401 Peoples Bank Bldg.
Salt Lake City, Utah.—P. O. Box 785.

CONCORDIA SAFETY LAMP COMPANY, INC., THE............750-751
420 Fulton Bldg., Pittsburgh, Pa.

CONCRETE PRODUCTS CO. OF PITTSBURG 591
803 Diamond Bank Bldg., Pittsburgh, Pa.

CONNELLSVILLE MFG. & MINE SUPPLY CO., THE....338-372-373-558
Connellsville, Pa.
Branch Offices:
Birmingham, Ala. — J. I. Blount, Brown-Marx Bldg.

CONTRACTORS' MACHINERY & SUPPLY COMPANY 428
509-11 Wabash Bldg., Pittsburgh, Pa.

COPPUS ENGINEERING & EQUIPMENT CO.........................238
Worcester, Mass.
Branch Offices:
Chicago, Ill.—Monadnock Bldg.
Cleveland, Ohio—Leader-News Bldg.
New York, N. Y.—52 Vanderbilt Ave.
Philadelphia. Pa.—Bourse Bldg.
Pittsburgh, Pa.—B. F. Jones Bldg.
Canadian Branch Office:
Montreal, Can.—380 St. James St.

CRANE COMPANY 276-277
836 S. Michigan, Ave., Chicago, Ill.
Works:
Chicago, Ill., and Bridgeport, Conn.
Branch Offices:
Aberdeen, S. D. (Crane & Ordway Co.), R. A. Hodgson, Mgr., 324 Railroad Ave., S. E.
Atlanta, Ga.—E. H. Thompson, Mgr., 31 Garnett St.
Baltimore, Md.—H. W. Seymour, Mgr., 626 W. Pratt St.
Birmingham, Ala.—W. H. Kettig, Mgr., 2 S Twentieth St.
Boston, Mass.—E. C. Townsend, Mgr., 48 W. First St. (South Boston).
Bridgeport, Con.—H. Hounslea, Mgr. City Store, 510 Main St.
Brooklyn, N. Y.—R. E. Wall, Mgr., 249 Willoughby St.
Buffalo, N. Y.—F. W. Zander, Mgr., 81 Broadway.
Chicago (City Sales Dept.)—J. Austin Murphy, Mgr., 156 N. Jefferson St.
Cincinnati, O.—Geo. B. Hawley, Mgr., 824 Broadway.
Davenport, Iowa—W. T. Cotter, Mgr., 600 E. Fourth St.
Des Moines, Iowa—M. M. Mitchell, Mgr., 1440 Walnut St.
Detroit, Mich.—J. A. Roe, Mgr., 2 Randolph St.
Duluth, Minn. (Crane & Ordway Co.)—P. R. Mork, Mgr., 8 E. Michigan St.
Fargo, N. D. (Crane & Ordway Co.)—J. E. Dady, Acting Mgr., 636 Northern Pacific Ave.
Grand Rapids, Mich.—R. J. Douglass, Mgr., 56 Ellsworth Ave.
Great Falls, Mont. (Crane & Ordway Co.), C. S. O'Brien, Mgr., P. O. Box 1754, Great Northern Ry. Yards.
Indianapolis, Ind.—R. A. MacGill, Mgr., 333 W. Market St.
Kansas City, Mo.—E. H. Graham, Mgr., 1328 W. Eleventh St.
Kansas City, Mo.—Up-town Show Room, 1324 Grand Avenue.
Knoxville, Tenn.—J. T. Grene, Mgr., 607 State St.
Little Rock, Ark.—R. T. Clarkson, Mgr., 400 E. Second St.
Los Angeles, Cal.—E. H. Hunt, Mgr., 321 E. Third St.
Memphis, Tenn.—Wm. Ross, Mgr., 254 Court Ave.
Minneapolis, Minn.—G. A. Chaffee, Mgr., 400 Third Ave., North.
Muskogee, Okla.—F. A. Malatesa, Mgr., 302 Commercial St.
Newark, N. J.—F. J. Allen, Mgr., 86 Mechanic St.
New York, N. Y.—F. E. Lally, Mgr., 494 Cherry St.
New York, N. Y.—Crane Exhibit Rooms, 23 W. 44th St., 22 W. 45th St.
Oakland, Cal.—J. W. Hotes, Mgr., 346 Ninth St.
Oklahoma City, Okla.—F. E. Georgia, Mgr., 221 W. First St.
Omaha, Neb.—J. E. Ludlow, Mgr., 323 S. Tenth St.
Philadelphia, Pa.—M. D. Robinson, Mgr., 245 Master St.
Portland, Ore.—F. A. Nitchy, Mgr., 160 N. Fourteenth St.
Sacramento, Cal.—S. S. Day, Mgr., 1227 Front St.
Salt Lake City, Utah—L. B. Hampton, Mgr., 307 W. Second South St.
San Francisco, Cal.—C. W. Weld, Mgr., 301 Brannan St.
Seattle, Wash.—L. B. Peeples, Mgr., 419 Second Ave., South.
Sioux City, Iowa—H. L. Wood, Mgr., 223 Jackson St.
Spokane, Wash.—W. K. Glen, Mgr., 126 S. Post St.
Springfield, Mass.—H. R. Wolcott, Mgr., 62 Hampden St.
St. Louis, Mo.—E. H. Boehnken, Mgr., 30 S. Sixteenth St.
St. Paul, Minn. (Crane &Ordway Co.), —L. P. Ordway, Vice-President and Treas., 283 E. Fifth St.
St. Paul, Minn.—Up-town Show Room, 55 W. Fourth St.
Syracuse, N. Y.—C. B. Porter, Mgr., 209 S. West St.
Tacoma, Wash.—S. J. Ball, Mgr., 1209 South A St.
Terre Haute, Ind.—E. W. Miller, Mgr., 209 Ninth St.
Vancouver, B. C.—J. E. McIlreevy, Mgr., 540 Beatty St.
Washington, D. C.—C. P. L. Moran, Mgr., 1221 Eye St., N. W.
Wichita, Kan.—C. Philipp, Mgr., 135 N. Water St.
Winnipeg, Man.—H. M. Agnew, Mgr., 93 Lombard St.
Warehouses
Camden, N. J.—S. C. Fish, Mgr., 23-29 N. Second St.
Ogden, Utah—T. J. Thomas, Mgr., Twentieth St. and Wall Ave.
Pocatello, Idaho—F. M. Conely, Mgr., First Ave. and Putnam St.
Savannah, Ga.—Milton U. Kent, Mgr., River St. and Merchants and Miners Wharf.
Watertown, S. D.—Wm. Langwill, Mgr., 141 Dakota Ave.
Representatives:
Washington, D. C.—W. H. Franklin (Government Department), 1221 Eye St.
Denver, Colo.—F. W. Knapp, 402 Boston Bldg.
Pittsburgh, Pa.—T. K. McKnight, 630 Oliver Bldg.
Montreal, Que.—W. J. Wall, 34 Bleury St.
Sanitary Goods Assembling Department.
Trenton, N. J.
F. W. McIntyre, Mgr., 46 Escher St.

CRAWFORD & McCRIMMON CO....374
Brazil, Ind.

CROSS ENGINEERING CO.........122
Carbondale, Pa.

CUTLER-HAMMER MFG. CO. THE 348-349
Milwaukee, Wis.
Sales Offices:
Boston, Mass. — The Cutler-Hammer Mfg. Co., 77 Franklin St.
Chicago, Ill. — The Cutler-Hammer Mfg. Co., Peoples Gas Bldg.
Cincinnati, O. — The Cutler-Hammer Mfg. Co., Gwynne Bldg.
Cleveland, O. — The Cutler-Hammer Mfg. Co., Guardian Bldg.
Kansas City, Mo. — Barber-Dwinnell Co., 600 East 15th St.
Los Angeles, Cal.—H. B. Squires, San Fernando Bldg.
New York, N. Y.—The Cutler-Hammer Mfg. Co., 50 Church St.
Philadelphia, Pa. — The Cutler-Hammer Mfg. Co., Commonwealth Bldg.
Pittsburgh, Pa.—The Cutler-Hammer Mfg. Co., Farmers Bank Bldg.
San Francisco, Cal. — H. B. Squires, 583 Howard St.
Seattle, Wash. — H. B. Squires, 309 First Ave., South.

CYCLONE GRATE-BAR CO.........239
Buffalo, N. Y.
Agencies:
Chicago, Ill.—M. H. Detrick Co., 549 W. Washington St., Western Rep.
Detriot, Mich.—L. S. Shaw & Co., Dime Bank Bldg.
Philadelphia, Pa.—Jay G. Thomas, 34 S. 17th St.
Worcester, Mass.—Geo. U. Ladd, 28 Dayton St., New England Agent.

D

D & W FUSE COMPANY..........649
Providence, R. I.
Agents:
Western Electric Co., Inc.
Atlanta, Ga.
Birmingham, Ala.
Boston, Mass.
Buffalo, N. Y.

Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Dallas, Tex.
Denver, Colo.
Detroit, Mich.
Houston, Tex.
Indianapolis, Ind.
Kansas City, Mo.
Los Angeles, Cal.
Milwaukee, Wis.
Minneapolis, Minn.
Newark, N. J.
New Orleans, La.
New York, N. Y.
Oakland, Cal.
Oklahoma City, Okla.
Omaha, Neb.
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Ore.
Richmond, Va.
St. Louis, Mo.
St. Paul, Minn.
Salt Lake City, Utah.
San Francisco, Cal.
Savannah, Ga.
Seattle, Wash.

Representatives:
Boston, Mass. — Pettingell-Andrews Co.
Chicago, Ill.—Central Electric Co.
New York, N. Y.—A. Hall Berry, 71-73 Murray St.

Canadian Agencies:
Calgary, Alta.—General Supplies, Ltd.
Halifax, N. S.—John Starr, Son & Co., Ltd.
Montreal, Que.—Electrical Equipment Co.
Quebec, Que.—Mechanics Supply Co., Ltd.
Toronto, Ont.—Factory Products, Ltd.
Vancouver, B. C.—Frank Darling & Co.
Winnipeg, Man. — Bentz-Richardson Co.

DAUM, A. F.......................**665**
1157 Hodgkiss St., Pittsburgh, Pa.

DAVIS-BOURNONVILLE CO.......**706**
Jersey City, N. J.

Branch Offices:
Boston, Mass.
Chattanooga, Tenn.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Detroit, Mich.
Los Angeles, Cal.
New York, N. Y.
Philadelphia, Pa.
Pittsburgh, Pa.
St. Louis, Mo.
San Francisco, Cal.
Seattle, Wash.

Canadian Office:
Toronto.

DE LAVAL STEAM TURBINE CO...**559**
Trenton, N. J.

Representatives:
Birmingham, Ala.—N. C. Walpole, 2015 First Ave.
Boston, Mass.—Power Equipment Co., 131 State St.
Charlotte, N. C.—Fraser-Purser Co., Commercial Bank Bldg.
Chicago, Ill.—De Laval S. T. Co., Peoples Gas Co.
Cleveland, O.—Dravo-Doyle Co., Citizens Bldg.
Duluth, Minn.—Rich, Raley & Co., 216 Providence Bldg.
Indianapolis, Ind.,— Dravo-Doyle Co. Merchants Bank Bldg.
Kansas City, Mo.—Thermal Efficiency Co., 716 Finance Bldg.
New Orleans, La.—Walter Castanedo, 1103 Hennen Bldg.
New York, N. Y.—Turbine Equipment Co., 50 Church Street.
Philadelphia, Pa. — Dravo-Doyle Co., Commercial Trust Bldg.
Pittsburgh, Pa. — Dravo-Doyle Co., Diamond Bank Bldg.
Salt Lake City, Utah—N. L. Alison, Boston Bldg.
San Francisco, Cal.—Herzog Elec. & Engr. Co., 150 Steuart St.
Seattle Wash.—De Laval Steam Turbine Company, L. C. Smith Bldg.

Canadian Representatives:
Montreal, Can. — E. Laurie Co., 243 Bleury St.
Toronto, Can. — Turbine Equip. Co.. Ltd., C. P. R. Bldg.
Vancouver, B. C.—Taylor Engr. Co., Ltd., Credit Foncier Bldg.

DEMING COMPANY, THE
.......**560-561-562-563-564-565-566-567**
Salem, O.

Agencies:
Birmingham, Ala.—Moore & Handley Hdwe. Co.
Boston, Mass. — Chas. J. Jager Co., 13-15 Custom House St.
Charlotte, N. C. — Thos. B. Whitted, Realty Bldg.
Chattanooga, Tenn. — James Supply Co.
Chicago, Ill.—Henion & Hubbell, 217-221 North Jefferson St.
Denver, Colo. — Hendrie & Bolthoff Mfg. & Supply Co.
Detroit, Mich.—Kerr Machinery Co.
El Paso, Tex.—El Paso Foundry & Machine Co.
Kansas City, Mo. — English Tool & Supply Co.
Knoxville, Tenn.—C. M. McClung & Co.
Los Angeles, Cal.—Chas. H. Sheldon.
Nashville, Tenn. — John Bouchard & Sons Co., 11th & Harrison St.
New York, N. Y. — Ralph B. Carter Co., 152 Chambers St.
Philadelphia, Pa.—W. P. Dallett, 49 North Seventh St.
Pittsburgh, Pa.—Harris Pump & Supply Co., 320-322 Second Ave.
Providence, R. I.—Chas. J. Jager Co., 33 Canal St.
Richmond, Va.—Sydnor Pump & Well Co., 1310 East Main St.
Seattle, Wash.—Perine Machinery Co.
Toledo, O.—Joseph L. Skeldon Engineering Co.
Washington, D. C.—Columbia Pump & Well Co., 520 Twelfth St.

Export Office:
New York City—90 West St.

Canadian Office:
Montreal, Que., Can. — Darling Bros., Ltd.

DEMPCY-DEGENER CO. **91**
307 Fourth Ave., Pittsburgh, Pa.

Branch Office:
Wilkes-Barre, Pa.—Rudolph Degener, 213 Coal Exchange Bldg.

DETROIT GRAPHITE CO...........**168**
Detroit, Mich.

Branch Offices:
Birmingham, Ala.—1724 Jefferson Co. Bank Bldg.
Boston, Mass.—101 Milk St.
Buffalo, N. Y.—871 Ellicott Square.
Chicago, Ill.—1646 Monadnock Block.
Cincinnati, O. — 705 Provident Bank Bldg.
Cleveland, O.—Blors Exchange, Rose Bldg.
Greenville, S. C.—213 Manly St.
Kansas City, Mo.—516 Reliance Bldg.
New York, N. Y.—Equitable Bldg.
Philadelphia, Pa. — 808 Land Title Bldg.
St. Louis, Mo. — Railway Exchange Bldg.
San Francisco, Cal.—708 Mills Bldg.
Springfield, Mass.—Stearns Bldg.

DIAMOND CONSTRUCTION COMPANY **187**
Huntington, W. Va.

Branch Office:
Logan, W. Va.

DIAMOND MACHINE COMPANY...**375**
Monongahela, Pa.

Agents:
Charleston, W. Va.—Cooke-Wilson Co.
Pittsburgh, Pa. — Cooke-Wilson Electric Supply Co.

DIXON, JOSEPH, CRUCIBLE CO...**300**
Jersey City, N. J.

Sales Offices:
Atlanta, Ga.—J. Lewis, 328 Peachtree St.
Baltimore, Md.—Wm. Houston, 616 Professional Bldg.
Boston, Mass.—H. Neally, 347 John Hancock Bldg.
Buffalo, N. Y.—J. A. Condit, Erie Co. Savings Bank Bldg.
Chicago, Ill.—D. A. Johnson, 1323-27 Monadnock Bldg.
New York, N. Y.—J. A. Ready, 68 Reade St.
Philadelphia, Pa.—W. G. Stringer, 1020 Arch St.
San Francisco, Cal.—A. G. Bowles, 155 Second St.
St. Louis, Mo.—H. A. VanDerslice, 501 Victoria Bldg.

DODGE SALES & ENGINEERING CO. **114-115-292-293-336-337**
Mishawaka, Ind.

Branch Warehouses:
Atlanta, Ga.—28 S. Forsyth St
Boston, Mass.—137 Purchase St.
Chicago. Ill.—208 S. Clinton St.
Cincinnati, O.—126 W. Third St.
Dallas, Tex.—Busch Bldg.
Indianapolis, Ind. — Merchants Bank Bldg.
Minneapolis, Minn.—100 N. Third St.
New York, N. Y.—21 Murray St.
Newark, N. J.—59 Mechanic St.
Philadelphia, Pa.—815 Arch St.
Pittsburgh, Pa.—337 Second Ave.
Portland, Ore.—Link-Belt Company of Washington.
Providence, R. I.—171 Pine St.
St. Louis, Mo.—408 N. Fourth St.
Seattle, Wash.—522 First Ave., So.
Utica, N. Y.—211-213 John St.

DONALDSON IRON CO.........**588-589**
Emaus, Pa.

DOUBLEDAY-HILL ELECTRIC CO.684
719-721 Liberty Ave.,
Pittsburgh, Pa.

Branch Office:
Washington, D. C.—727 Twelfth St., Northwest.

DRAEGER OXYGEN APPARATUS CO., THE **764-765**
Wilkinsburg Station, Pittsburgh, Pa.

Factory:
Wilkinsburg Station, Pittsburgh, Pa.

Eastern Representatives:
Baltimore, Md.—W. J. McGinnis, 412 E. Twenty-second St.
New Haven, Conn.—O. L. Goudey, 18 Parker Place.
New York, N. Y.—Wolf Safety Lamp Co. of America, Inc., 74-80 Washington St.

Western Manager:
Seattle, Wash.—H. H. Sanderson, 2011 L. C. Smith Bldg.

Branch Office:
Denver, Colo.
Duluth, Minn.—Fred H. Waldron Co., 202 Torrey Bldg.
El Paso, Texas.
Maywood, Ill.—. W. Hoyt, 814 N. Fifth Ave.
Pittsburgh, Pa.—A. J. Menny, C. A. Purcell.
St. Louis, Mo.—C. C. McDaniel, 4069 Flad Ave.
Salt Lake City, Utah.
San Francisco, Cal.—A. W. V. Johnson, Merchants Exchange Bldg.

Canadian Officer:
Winnipeg, Manitoba, Can.—Frank E. Filer, 302 Donalda Block.

DRAKE, A. W., DRILLING CO.......**66**
712-713 Markle Bank Bldg., Hazleton, Pa.

DRAVO CONTRACTING CO., THE...**71**
Diamond Bank Bldg., Pittsburgh, Pa.

DRAVO-DOYLE COMPANY.....**382-568**
Diamond Bank Bldg., Pittsburgh, Pa.

Branch Offices:
Cleveland, O.—Citizens Bldg.
Indianapolis, Ind. — Merchants Bank Bldg.
Philadelphia, Pa. — Commercial Trust Bldg.

DUBOIS IRON WORKS.............**569**
Dubois, Pa.

DUDLEY ELECTRIC & MACHINE CO. **685**
7 E. Fayette St., Uniontown, Pa.

Branch Offices:
Clarksburg, W. Va.—422 N. 4th St.
South Brownsville, Pa.—Second St.

DUFF MFG. CO., THE..............**777**
Pittsburgh, Pa.

Branch Offices:
Atlanta, Ga.—Candler Bldg.
Chicago, Ill.—Peoples Gas Bldg.
Denver, Colo.—First Natl. Bank Bldg.
New York, N. Y.—50 Church St.
St. Paul, Minn.—Pioneer Bldg.
San Francisco, Cal.—Monadnock Bldg.

DUNCAN FOUNDRY & MACHINE WORKS **455**
Alton, Ill.

DU PONT CHEMICAL WORKS.....**169**
120 Broadway, New York, N. Y.

Branch Office:
Chicago, Ill.—James H. Furman Co., 326 West Madison St.

List of Firms Catalogued Branch Offices Representatives and Agencies---Cont.

DU PONT, E. I., DE NEMOURS & CO. 736-737-738-739
Du Pont Bldg., Wilmington, Del.
Branch Offices:
Birmingham, Ala.—C. J. Perry, Mgr., Brown-Marx Bldg.
Buffalo, N. Y.—E. N. McCarney, 510 Prudential Bldg.
Chicago, Ill.—J. F. Wishart, Mgr., McCormick Bldg.
Denver, Colo. — C. W. Phellis, Mgr., Ideal Bldg.
Duluth, Minn. — F. D. Orr, Mgr., Fidelity Bldg.
Huntington, W. Va.—J. E. Miller, Mgr., Robson-Prichard Bldg.
Joplin, Mo.—E. F. Lednum, Frisco Bldg.
Juneau, Alaska—R. E. Murphy, Pond Bldg.
Kansas City, Mo.—J. J. Craddock, Scarritt Bldg.
Mexico City, Mexico—J. G. Calderon, Edeficio de La Mutua Compania de Seguros Sobre La Vida de Neura York.
New York, N. Y.—F. C. Peters, Mgr., Equitable Bldg.
Pittsburgh, Pa.—F. W. Pichard, Mgr., May Bldg., Cor. Fifth and Liberty Aves.
Portland, Ore. — George E. Willman, 244 Stark St.
San Francisco, Cal.—W. A. Joslyn, Mgr., Chronicle Bldg.
Seattle, Wash.—J. H. Willman, Mgr., Maynard Bldg.
Spokane, Wash. — Harry Witt, 523 First Ave.
Springfield, Ill.—G. K. Larrimore.
St. Louis, Mo. — W. E. Pratt, Mgr., Wright Bldg.
Scranton, Pa.—Henry Belin, Jr., Pres., E. I. du Pont de Nemours & Co., of Penna.

DUQUESNE ELECTRIC & MANUFACTURING CO. 692
Pittsburgh, Pa.
Branch Office:
Cleveland, O.—507 Marshall Bldg.

DURABLA MANUFACTURING COMPANY 286
114-118 Liberty St., New York, N. Y.
Branch Offices:
Chicago, Ill.—Hunter Bldg.
Pittsburgh, Pa.—Hartje Office Bldg.
Philadelphia, Pa.—27 North Seventh St.

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EAGLE PIPE SUPPLY CO., INC....594
30 Church St., New York, N. Y.
Warehouse:
West Ave. and Sixth St., Long Island City, N. Y.

ECONOMY DRAWING TABLE COMPANY 78-79
Toledo, Ohio.
Factory:
Adrian, Mich.

ECONOMY FUSE AND MANUFACTURING CO.......................666
Kinzie and Orleans St.,
Chicago, Ill.
Branch Offices:
Atlanta, Ga.—1209 Fourth Natoinal Bank Bldg.
Baltimore, Md.—444 Equitable Bldg.
Boston, Mass.—161 Summer St.
Buffalo, N. Y.—604 Electric Bldg.
Cincinnati, O.—Greenwood Bldg.
Cleveland, O.—715 Citizens Bldg.
Detroit, Mich.—1212 Majestic Bldg.
Milwaukee, Wis.—1011 Majestic Bldg.
New York, N. Y.—30 Church St.
Philadelphia, Pa.—The Bourse Bldg.
Pittsburgh, Pa.—2223 Farmers Bank Bldg.
St. Louis, Mo.—301 Frisco Bldg.
Seattle, Wash.—936 Henry Bldg.

ECONOMY RAIL BOND CO., THE...653
Huntsville, Mo.

EDISON LAMP WORKS............754
Harrison, N. J.

EDISON STORAGE BATTERY CO. 496-749
232 Lakeside Ave., Orange, N. J.
Distributors:
Boston, Mass.
Chicago, Ill.
Detroit, Mich.
New Orleans, La.
New York, N. Y.
Los Angeles, Cal.
Pittsburgh, Pa.
San Francisco, Cal.
Seattle, Wash.

ELECTRIC RAILWAY EQUIPMENT CO. 660
Cincinnati, O.
Representatives:
Birmingham, Ala.—Moore-Handley Hardware Co. (Elect. Dept.).
Bluefield, W. Va.—Superior Supply Co. (Elect. Dept.).
Charleston, W. Va.—Cooke & Wilson Co.
Chicago, Ill.—Electrical Material Co., 618 W. Jackson Blvd.
Denver, Colo.—The O. H. Davidson Equipment Co.
Hazard, Ky.—Arthur L. Ware.
Jellico, Tenn.—Arthur L. Ware.
Knoxville, Tenn.—C. M. McClung & Co.
New York, N. Y.—Electric Railway Equipment Co., 30 Church St.
Pittsburgh, Pa. — Cooke-Wilson Electric Supply Co., Penn Ave. and Barbeau St.
Salt Lake City, Utah—The O. H. Davidson Equipment Co., Walker Bank Bldg.
St. Louis, Mo.—Wood & Lane Company, 915 Olive St.
Pacific Coast—Eccles & Smith Co.

ELECTRIC SERVICE COMPANY, THE 686
212 Walnut St., Cincinnati, O.

ELECTRIC SERVICE SUPPLIES CO. 506-656-657
17th and Cambria Sts., Philadelphia, Pa.
Branch Offices:
Atlanta, Ga.—1526 Candler Bldg.
Chicago, Ill.—Monadnock Bldg.
New York, N. Y.—50 Church St.
Agencies:
Birmingham, Ala. — McClary-Jemison Machinery Co.
Denver, Colo.—Franklin Sales Co.
Los Angeles, Cal.—403 Trust & Savings Bldg., S. I. Wailes.
Portland, Ore.—54 First St., W. F. McKeeney.
San Francisco, Cal.—903 Monadnock Bldg., Frank F. Bolder.
Wheeling, W. Va.—Gee Electric Co.
Canadian Agencies:
Montreal, Que., Can.—Lyman Tube & Supply Co.
Toronto, Ont., Can.—Lyman Tube & Supply Co.

ELECTRIC STORAGE BATTERY CO., THE 497
Allegheny Ave. and Nineteenth St.,
Philadelphia, Pa.
Sales Offices:
Atlanta, Ga.—Cor. Peachtree and Baker Sts.
Boston, Mass.—718-730 Beacon St.
Chicago, Ill.—Marquette Bldg.
Cleveland, O.—Citizens Bldg.
Denver, Colo.—Geo. D. Luther, Soliciting Agent, 1424 Wazee St.
Detroit, Mich.—1158 Cass Ave.
Kansas City, Mo.—H. B. Marshall, Soliciting Agents, 17th and Walnut Sts.
Minneapolis, Minn.—P. G. Downton, Soliciting Agent, 3 N. 15th St.
New York, N. Y.—100 Broadway.
Pittsburgh, Pa.—Keystone Bldg.
Rochester, N. Y.—184 Clinton Ave., So.
St. Louis, Mo.—H. B. Marshall, Soliciting Agent, 1508 Federal Reserve Bank Bldg.
San Francisco, Cal.—Geo. R. Murphy, Soliciting Agent, 1536-1556 Bush St.
Washington, D. C.—1823-1833 L St., N. W.
Canadian Office:
Toronto, Ont., Can.—The Canadian General Electric Co., Ltd., King and Simcoe Sts.

ELECTRICAL MATERIAL COMPANY 673
618 West Jackson Blvd.,
Chicago, Ill.

ELLIOT FROG & SWITCH CO.......436
301 S. Main St., East St. Louis, Ill.
Branch Office and Works:
Pueblo, Colo.
Sales Representatives:
Houston, Texas—G. F. Cotter Supply Co., Southern Pacific Bldg.
Los Angeles, Cal.—H. W. Renick, Central Bldg.
New Orleans, La.—W. D. Jenkins, Hibernian Bank Bldg.
St. Paul, Minn.—Geo. M. Kenyon, Pioneer Press Bldg.

ELLIOTT, B. K., COMPANY.........75
Pittsburgh, Pa.
Branch Office:
Cleveland, O.—Wm. F. Chew, Mgr., 737 Prospect Ave.

ELMORE, G. H...............116-117-570
Philadelphia, Pa.
Agencies:
Birmingham, Ala.—Keiser & Geismer Engr. Co., American Trust Bldg.
Chicago, Ill.—Roberts & Schaefer Co., McCormick Bldg.
Duluth, Minn. — Waldron & Woodbridge, Torrey Bldg.
Seattle, Wash.—Percy E. Wright, L. C. Smith Bldg.
Seattle, Wash.—Brinkley Supply Co.
St. Louis, Mo.—Baumes-McDevitt Machinery Co.

EMPIRE CHEMICAL COMPANY....632
Huntington, W. Va.

ENGINEER COMPANY, THE.......235
17 Battery Place, New York, N. Y.
Branch Offices:
Boston, Mass.—10 High St.
Chicago, Ill.—McCormick Bldg.
Cleveland, O.—515 Garfield Bldg.
Philadelphia, Pa.—Harrison Bldg.
Pittsburgh, Pa.—Oliver Bldg.

ENSIGN-BICKFORD COMPANY, THE 746
Simsbury, Conn.
Canadian Representatives:
Cobalt, Ont.—Grodwards Co.
Sudbury, Ont.—Grodwards Co.
Timmins, Ont.—Grodwards Co.

ENTERPRISE FOUNDRY & MACHINE WORKS 458
Bristol, Tenn.
Representatives:
Birmingham, Ala.—Patton Sales Co., Brown-Marx Bldg.
Knoxville, Tenn.—Webster & Co., Holston Bank Bldg.
Philadelphia, Pa.—Thos. B. Whitney, 33 South Sixteenth St.
Pittsburgh, Pa.—Gellatly & Co., Union Bank Bldg.

EPPING-CARPENTER PUMP CO....571
Pittsburgh, Pa.
Branch Offices:
Baltimore, Md.—T. A. Wilkinson, 915 Equitable Bldg.
Birmingham, Ala. — McClary-Jamison Machinery Co.
Chicago, Ill.—Western Pump & Engineering Co.
Cleveland, O.—328 Champlain Ave.
Detroit, Mich.—Power Plant Supply Co., 612 Chamber of Commerce Bldg.
Huntington, W. Va.—Banks Supply Co.
New York, N. Y.—90 West St.
Philadelphia, Pa.—1108 Harrison Bldg.
Rochester, N. Y.—A. L. Covill, 728 Granite Bldg.

ERIE CITY IRON WORKS........227
Erie, Pa.
Agencies:
Allentown, Pa.—Traylor Engineering & Mfg. Co.
Atlanta, Ga.—Murray Co.
Baltimore, Md.—T. A. Wilkinson, 915 Equitable Bldg.
Boston, Mass.—L. N. Wheelock, 141 Milk St.
Buffalo, N. Y.—William Dempster, 67 Perry St.
Charleston, S. C.—Cameron & Barkley Co.
Chicago, Ill.—C. B. Acheson, Peoples' Gas Bldg.
Cincinnati, O.—W. C. Dunn, 26 Hulbert Block.
Clarksburg, W. Va.—W. B. Osburn.
Cleveland, O.—Hal H. Hill, Citizens Bldg.
Cortland, N. Y.—J. L. McKee Supply Co.
Dallas, Texas—Murray Co.
Denver, Colo.—T. B. Burnite.
Denver, Colo.—Hendrie & Bolthoff Mfg. & Supply Co.
Detroit, Mich.—W. A. Story, Majestic Bldg.
El Paso, Texas—Francis O'Neill, 123 San Francisco St.
Goldsboro, N. C.—Dewey Brothers.
Hancock, N. Y.—T. F. Stimpson.
Houston, Texas—H. A. Paine.
Jacksonville, Fla.—Cameron & Barkley Co.

Jamestown, N. Y.—C. S. Hale.
Joplin, Mo.—McNeal Machinery Co.
Kansas City, Mo.—English Tool & Supply Co., 410-418 West Fifth St.
Little Rock, Ark.—Ben D. Schaad.
Los Angeles, Cal.—Baker Iron Works.
Miami, Fla.—Cameron & Barkley Co.
Minneapolis, Minn.—B. L. Hanks, 28-29 Corn Exchange Bldg.
Muncy, Pa.—Sprout, Waldron & Co.
Nashville, Tenn.—John P. Dale Machinery Co.
New Orleans, La.—William P. Luck, Godchaux Bldg.
New York, N. Y.—American Trading Co., 25 Broad St.
New York, N. Y.—W. R. Grace & Co., 1 Hanover Square.
New York, N. Y.—C. W. McHose, 1360-62 Woolworth Bldg.
New York, N. Y.—James Beggs & Co., 36 Warren St.
Norfolk, Va.—C. A. McLean, 412 Citizens Bldg.
Philadelphia, Pa.—E. G. Haring, 2124 Land Title Bldg.
Pittsburgh, Pa.—T. H. McGraw, Jr., Park Bldg.
Portland, Ore.—Edward G. Gordon, 55 First St.
Rochester, N. Y.—M. S. Gillette, 530 Plymouth Ave.
St. Louis, Mo.—A. A. Bonsack, 1935 Boatmens Bank Bldg.
Salisbury, Md.—L. W. Gunby Co.
Salt Lake City, Utah—Walter Green, 338 South Main St.
San Francisco, Cal.—Harron, Rickard & McCone, 139-149 Townsend St.
San Francisco, Cal.—Walter S. Leland, 67 Second St.
Seattle, Wash.—Brinkley Supply Co., 546 First Ave., South.

Canadian Agencies:
Montreal, Canada—John McDougall, Caledonian Iron Works Co.
Toronto, Ont.—H. W. Petrie, Ltd.

EVERHART BRASS WORKS, THE..394
Scranton, Pa.

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FAIRBANKS COMPANY, THE..135-275
Broome and Lafayette Sts., New York, N. Y.
Factories:
Binghamton, N. Y., Rome, Ga., St. Johnsbury, Vt.

Sales Offices:
Albany, N. Y.—360-366 Broadway.
Baltimore, Md. — Light and Lombard Sts.
Boston, Mass.—32-44 Pearl St.
Bridgeport, Conn. — Water St. and South Ave.
Buffalo, N. Y.—108 Pearl St.
Chicago, Ill.—Cor. Market and Lake Sts.
Hartford, Conn.—326-330 Pearl St.
Newark, N. J.—90-92 Academy St.
New Orleans, La.—900-926 Camp St.
New York, N. Y.—Broome and Lafayette Sts.
Philadelphia, Pa.—Arch and Seventh Sts.
Pittsburgh, Pa.—105 Wood St.
Providence, R. I.—74-78 Mathewson St.
St. Louis, Mo.—115 South Eleventh St.
Syracuse, N. Y.—Franklin and Walton Sts.

FAIRMONT MINING MACHINERY CO..92-93-94-95-96-440-441-572-573-624
Fairmont, W. Va.

Agencies:
Denver, Colo.—O. H. Davidson Equipment Co.
Huntington, W. Va.—Huntington Supply & Equipment Co.
Knoxville, Tenn.—Webster & Co.
Middlesboro, Ky.—Webster & Co.
Pittsburgh, Pa. — S. M. Casterline, Grace Ave., Crafton.

FALK COMPANY, THE.............389
Milwaukee, Wis.

Branch Offices:
Denver, Colo. — Denver Engineering Works.
New York, N. Y.—M. P. Fillingham, Hudson Terminal Bldg.
Pittsburgh, Pa.—W. O. Beyer, 1024 Park Bldg.
San Francisco, Cal.—F. W. Grimwood, Rialto Bldg.
Wilkes-Barre, Pa.—Vulcan Iron Wks.

FATE, J. D., COMPANY, THE.......503
Plymouth, Ohio.

FISCHER & HAYES ROPE COMPANY..........................402
602 West Lake Street,
Chicago, Ill.

FLOOD CITY MFG. CO.........658-659
Johnstown, Pa.

Agency:
Scranton, Pa.—Francis H. Coffin & Co., Board of Trade Bldg.

FLORY, S., MFG. CO............376-377
Bangor, Pa.

Agents:
Birmingham, Ala.—Chas. T. Lehman.
Chicago, Ill. — Clapp, Norstrum & Riley, 12 South Canal St.
Cleveland, O.—McKenna Co.
Huntington, W. Va. — Banks Supply Co.
Little Rock, Ark.—C. E. Rosenbaum Machinery Co.
Memphis, Tenn. —Riechman-Crosby Co.
New York, N. Y.—Lenher Engineering Co., 95 Liberty St.
Norfolk, Va.—Henry Walke Co.
Philadelphia, Pa.—Allen Engineering Co., 907 Penna. Bldg.
San Francisco, Cal.—A. L. Young Machinery Co.

Canadian Agents:
Montreal, Que., Can.—Mussens, Ltd.
New Glasgow, N. S., Can.—I. Matheson Co.
Winnipeg, Man., Can.—Kelly Powell, Ltd., 602 McArthur Bldg.

FOSTER, L. B., CO.................429
Pittsburgh, Pa.

FOSTER ENGINEERING CO.......278
Newark, N. J.

Branch Offices:
Boston, Mass.—161 Sumner St.
Chicago, Ill.—180 N. Dearborn St.
Philadelphia, Pa.—Harrison Bldg.
Pittsburgh, Pa.—Arrott Bldg.

Agents:
Houston, Tex. — Ahrens & Ott Mfg. Co.
Louisville, Ky.—Ahrens & Ott Mfg. Co.
New Orleans, La.—Ahrens & Ott Mfg. Co.
Pittsburgh, Pa.—Standard Mfg. Co.
San Francisco, Cal.—Pacific Hardware & Steel Co.
Seattle, Wash.—Steam Supply & Rubber Co.

Canadian Agents:
Canadian-Fairbanks-Morse Co., Ltd.

FRANK, M. K.....................430
Frick Bldg., Pittsburgh, Pa.

FREEMAN MFG. CO...............228
Racine, Wis.

Agencies:
Chicago, Ill.—Freeman Mfg. Co., 530 Monadnock Bldg.
Cleveland, O. — Industrial Equipment Co., 208 American Trust Bldg.
Dallas, Tex.—J. U. Jones, 3819 Rawlin St.
Milwaukee, Wis.—Wm. T. Doyle, 167 Twelfth St.
Minneapolis, Minn.—Pocock & Pollard Co., 208 Iron Exchange.
Portland, Ore. — Colby Engineering Co., 70 First St.
St. Louis, Mo.—P-K Engineers, Syndicate Trust Bldg.
San Francisco, Cal.—H. F. Lyons Co., 33 California St.

FRICK & LINDSAY CO..........788-789
Pittsburgh, Pa.

Branch Offices:
Cleveland-West Park, O.
Clarksburg, W. Va.
Evans City, Pa.
Irvine, Ky.
Junction City, O.
Lancaster, O.
Marietta, O.
New Straitsville, O.
Winchester, Ky.

FRONT CONSTRUCTION COMPANY..........................693
Pittsburgh, Pa.

Branch Office:
Huntington, W. Va.—Oliver Maupin Co., County Court Bldg.

FULTON BAG & COTTON MILLS...354
330 Wythe Ave., Brooklyn, N. Y.
Atlanta, Ga. — South Blvd. and So. R. R.
Dallas, Tex.—Preston St. and Pacific Ave.
New Orleans, La.—South Peters and Gainnie Sts.
Oklahoma City, Okla.—719 Insurance Bldg.
St. Louis, Mo.—606 South Seventh St.

FULTON-KENOVA MINE CAR CO., THE..............459-460-461
Guardian Bldg., Cleveland, O.

Branch Offices:
Canal Fulton, O.—Fulton Pit Car & Mfg. Co.
Kenova, W. Va.—Kenova Mine Car Co.

FULTON TOOL CO., THE...........798
Huntington, W. Va.

Representatives:
Pittsburgh, Pa.—The Hartzell Sales Co., 7-9 West Canal St., N. S.
Huntington, W. Va. — The Hartzell Sales Co.
St. Louis, Mo.—W. R. Young, 74 Arundel Place.

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GARLOCK PACKING COMPANY, THE..........................287
Palmyra, N. Y.

Branch Offices:
Birmingham, Ala.—2027 Ave. B, South.
Boston, Mass.—88 Broad St.
Chicago, Ill.—326 W. Madison St.
Cleveland, O.—1365 Ontario St.
Denver, Colo.—1540 Cleveland Place.
New York, N. Y.—114 Liberty St.
Philadelphia, Pa.—1211 Arch St.
Pittsburgh, Pa.—Chamber of Commerce Bldg.
St. Louis, Mo.—1017 Olive St.
San Francisco, Cal.—670 Howard St.

Canadian Office:
Hamilton, Ont.—200 Queen St., North.

GEE ELECTRIC COMPANY........674
Wheeling, W. Va.

GEM MANUFACTURING CO........295
N. S., Pittsburgh, Pa.

Branch Offices:
Philadelphia, Pa.—R. J. Ridge, 1502 Real Estate Trust Bldg.

GENERAL ELECTRIC CO......133-248-249-351-390-391-486-487-507-586-625-661
Schenectady, N. Y.

Sales Offices:
Atlanta, Ga.—Third Natl. Bank Bldg.
Baltimore, Md.—Munsey Bldg.
Birmingham, Ala.—Brown-Marx Bldg.
Boston, Mass.—84 State St.
Butte, Mont.—Electric Bldg.
Chicago, Ill.—Monadnock Bldg.
Chattanooga, Tenn.—James Bldg.
Cincinnati, O.—Provident Bank Bldg.
Cleveland, O.—Illuminating Bldg.
Charleston, W. Va.—Charleston Natl. Bank Bldg.
Charlotte, N. C. — Commercial Natl. Bank Bldg.
Columbus, O. — Columbus Savings & Trust Bldg.
Dayton, O.—Schwind Bldg.
Denver, Colo.—First Natl. Bank Bldg.
Buffalo, N. Y.—10th Floor Elec. Bldg.
Dallas, Tex.—1701 N. Market St.
Des Moines, Ia.—Hippee Bldg.
Detroit, Mich.—G. E. Co. of Michigan, Dime Savings Bank Bldg.
Duluth, Minn.—Fidelity Bldg.
El Paso, Tex.—500 San Francisco St.
Erie, Pa.—Marine Bank Bldg.
Elmira, N. Y.—Hulett Bldg.
Ft. Wayne, Ind.—Ft. Wayne Electric Works.
Houston, Tex.—Third and Washington Sts.
Indianapolis, Ind.—Traction Terminal Bldg.
Jackson, Fla.—Heard Natl. Bank Bldg.
Joplin, Mo.—Miners Bank Bldg.
Kansas City, Mo.—Dwight Bldg.
Knoxville, Tenn.—Burell Bldg.
Los Angeles, Cal.—724 So. Spring St.
Louisville, Ky.—Starks Bldg.
Memphis, Tenn.—Randolph Bldg.
Milwaukee, Wis.—Public Service Bldg.
Minneapolis, Minn. — 410 Third Ave., North.
Nashville, Tenn.—Stahlman Bldg.
New Orleans, La. — Maison-Blanche Bldg.
New Haven, Conn.—Second National Bank Bldg.
New York, N. Y.—Equitable Bldg., 120 Broadway.
Niagara Falls, N. Y.—Gluck Bldg.
Omaha, Neb.—Union Pacific Bldg.
Oklahoma City, Okla.—Terminal Bldg.

Philadelphia, Pa.—Witherspoon Bldg.
Pittsburgh, Pa.—Oliver Bldg.
Portland, Ore.—Electric Bldg.
Providence, R. I.—1012 Turks Head Bldg.
Rochester, N. Y.—Granite Bldg.
Richmond, Va.—Virginia Rwy. & Pr. Bldg.
Salt Lake City, Utah. — Newhouse Bldg.
San Francisco, Cal.—Rialto Bldg.
Schenectady, N. Y.—G. E. Works.
Seattle, Wash.—Colman Bldg.
St. Louis, Mo.—Pierce Bldg.
Springfield, Mass. — Mass. Mutual Bldg.
Spokane, Wash.—Paulsen Bldg.
Syracuse, N. Y.—Onondaga Co. Sav. Bank Bldg.
Toledo, O.—Spitzer Bldg.
Washington, D. C.—Stanbaugh Bldg.
Youngstown, O.—Evans Bldg.

GENERAL ROOFING MFG. CO.......181
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GLAMORGAN PIPE & FOUNDRY CO. 588-589
Lynchburg, Va.
General Sales Office:
Chicago, Ill.—431 The Rookery.

GOODIN, REID & COMPANY.......356
Cincinnati, Ohio.

GOODMAN MFG. CO. 485-614
4834 So. Halsted St., Chicago, Ill.
Branch Offices:
Birmingham, Ala.—General Machinery Co., Brown-Marx Bldg.
Charleston, W. Va.—1208 Union Bldg.
Cincinnati, O.—317-321 Sycamore St.
Denver, Colo. — Lindrooth-Shubart & Co., Boston, Bldg.
Pittsburgh, Pa.—2218 Farmers Bank Bldg.
St. Louis, Mo.—1501 Boatmen's Bank Bldg.
Seattle, Wash. — L. W. Shirley, 576 First Ave., South.

GOODRICH, B. F. CO., THE.....125-288
Akron, Ohio.
Branches and Depots:
Birmingham, Ala.—424 S. 20th St.
Boston, Mass.—851 Boylston St.
Buffalo, N. Y.—1050-52 Main St.
Chicago, Ill.—1925 Michigan Ave.
Denver, Colo.—1422 Court Place.
Detroit, Mich. — Woodward Ave. and Hancock St.
Joplin, Mo.—216 W. Fourth St.
London, England. — 117 Golden Lane, E. C.
Los Angeles, Cal.—11th and Oliver Sts.
New York, N. Y.—1780 Broadway.
Norfolk, Va.—223 Water St.
Philadelphia, Pa.—519 N. Broad St.
San Francisco, Cal.—401 Mission St.
Seattle, Wash.—113 King St.
Syracuse, N. Y.—117 W. Taylor St.
Special Distributors.
Akron, O.—Union Rubber Co.
Atlanta, Ga.—Southern Rubber & Supply Co.
Beaumont, Tex.—E. L. Wilson Hardware Co.
Cincinnati, O.—Atlas Rubber & Belting Co.
Cleveland, O.—Forest City Rubber Co., 1276 Ontario St.
Columbus, O.—Columbus Mill & Mine Supply Co.
Dayton, O.—Atlas Rubber & Belting Co.
Houston, Tex. — Southern Rubber & Belting Co.
Indianapolis, Ind.—Central Rubber & Supply Co.
Jacksonville, Fla.—J. G. Christopher Co.
Louisville, Ky.—Laib Co.
Macon, Ga.—J. S. Schofield's Sons Co.
Nashville, Tenn.—Keith, Simmons & Co.
New Orleans, La. — Whitney Supply Co.
Pittsburgh, Pa.—Speck-Marshall Co.

GOULD STORAGE BATTERY CO...498
30 E. 42nd St., New York, N. Y.
(Factory, Depew, N. Y.)
Branch Offices:
Chicago, Ill.—225 E. 22nd St.
Cleveland, O.—1765 E. 18th St.
Detroit, Mich.—100 Beaubien St.
Los Angeles, Cal.—118 E. Pico St.
Philadelphia, Pa.—613 Lincoln Bldg.
Pittsburgh—Union Arcade Bldg.
San Francisco, Cal.—1448 Van Ness Ave.

GOULDS MANUFACTURING CO........
..................................574-575
Seneca Falls, N. Y.
Branch Offices:
Atlanta, Ga.—Third Natonal Bank Bldg.
Baltilmore, Md.—304 Continental Bldg.
Boston, Mass.—58 Pearl St.
Chicago, Ill.—12-14 S. Clinton St.
Houston, Texas—1001 Carter Bldg.
New York, N. Y.—16 Murray St.
Philadelphia, Pa.—111 No. Third St.
Pittsburgh, Pa.—636 Henry W. Oliver Bldg.
Agencies:
Baltimore, Md.—Chafard — Norris.
Bluefield, W. Va.—Stephen H. Meem Co.
Cincinnati, O.—J. M. Wikel Engr. Co.
Cleveland, O.—Robert R. Harkins, Schofield Bldg.
Denver, Colo.—Mine & Smelter Supply Co.
El Paso, Texas—D. A. Carpenter & Co.
Los Angeles, Cal.—Smith-Booth-Usher Co.
St. Louis, Mo.—Bonsack Machinery Co., Boatmen's Bank Bldg.
Salt Lake City, Utah—Galigher Machinery Co.

BRASSELLI POWDER CO.........735
Cleveland, O.
Branch Offices:
Chicago, Ill.
Emporium, Pa.
Pittsburgh, Pa.
Factories and Distributing Warehouses:
Akron, O.
Clarksburg, W. Va.
Columbus, Ohio.
Cumberland, Md.
Emporium, Pa.
Fostoria, Ohio.
Grand Rapids, Mich.
Joliet, Ill.
Leckrone, Pa.
Ladysmith, Wis.
Lowellville, Ohio.
New Castle, Pa.
Saginaw, Mich.

GREEN, L. A.......................431
First Natl. Bank Bldg., Pittsburgh, Pa.

GRIER BROS. CO., THE............758
124 Second Ave., Pittsburgh, Pa.

GUSTAFSON MFG. CO...............462
Chattanooga, Tenn.

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HAGAN, GEORGE J., COMPANY....245
Fourth Floor Peoples Bank Bldg.,
Pittsburgh, Pa.
Agencies:
Boston, Mass.—Henry J. Sage, 79 Milk St.
Chicago, Ill.—The Reordway Co., Marquette Bldg.
Cleveland, O.—Geo. J. Hagan Co., 4th Floor, Garfield Bldg.
New York, N. Y.—Frank W. Richardson, 39-41 Cortlandt St.
Philadelphia, Pa.—Eugene Hahn, 709 Harrison Bldg.
St. Louis, Mo.—O. L. Collins & Son, 6th Floor Bank of Comemrce Bldg.

HARDSOCG, MARTIN, CO., THE
..............................800-801
Pittsburgh, Pa.
Branch Office:
Hardsocg Mfg. Co., Ottumwa, Iowa.

HARDSOCG MFG. CO. 800-801
Ottumwa, Ia.
Branch Office:
Evansville, Ind.

HARKER MANUFACTURING COMPANY 759
410 Pearl Street, East,
Cincinnati, Ohio.
Agencies:
Jellico, Tenn.—Jellico Hardware Co.
Spokane, Wash.—Holley-Mason Hdwe. Co.
Canadian Agencies:
Calgary, Alta. — Foundry Products, Ltd.
Vancouver, B. C.—Langley & Hazlitt, Ltd.

HARRIS PUMP & SUPPLY CO......
..........................189-297-576-790
Pittsburgh, Pa.
Branch Office:
Philadelphia, Pa.—1414 Pennsy Bldg.

HARRISON SAFETY BOILER WORKS 262
17th St. and Allegheny Ave.,
Philadelphia, Pa.
Representatives:
Birmingham, Ala.—W. F. Trenary, Jr., Bisbee Bldg.
Boston, Mass.—Oliver Bldg.
Chicago, Ill. — A. Sorge, Jr., & Co., Monadnock Block.
Cincinnati, O.—H. P. Thompson, Mercantile Library Bldg.
Cleveland, O.—Dravo-Doyle Co.
Detroit, Mich.—F. H. Mason, Moffatt Bldg.
Easton, Pa.—Macon, Jr., Co.
Huntington, W. Va.—Miller Supply Co.
Houston, Tex. — H. A. Paine, 1302 Nance St.
Indianapolis, Ind. — I. C. DeHaven, State Life Bldg.
Jacksonville, Fla.—W. R. Jennison, Bisbee Bldg.
Kansas City, Mo.—R. V. Jones, Finance Bldg.
Los Angeles, Cal.—Chas. C. Moore & Co., Engrs.
New Orleans, La.—Walter Castanedo, Hennen Bldg.
New York, N. Y. — F. E. Idell, 50 Church St.
Pittsburgh, Pa.—Dravo-Doyle Co.
Salt Lake City, Utah—Chas. C. Moore & Co., Engrs.
San Francisco, Cal.—Chas. C. Moore &
Scranton, Pa.—Scranton Supply & Machine Co.
Seattle, Wash.—Chas. C. Moore & Co., Engrs.
Syracuse, N. Y.—J. N. Beeler, Bastable Bldg.
St. Louis, Mo. — W. L. Flower Co., Cupple Block.
Tucson, Ariz.—Chas. C. Moore & Co., Engrs.
Canadian Representative:
Toronto, Can.—Canadian Allis-Chalmers, Ltd., King and Simcoe Sts.

HAZARD MFG. CO...............403-650
Wilkes-Barre, Pa.
Branch Offices:
Chicago, Ill.—552 W. Adams St.
New York, N. Y.—533 Canal St.
Pittsburgh, Pa.—2213 First National Bank Bldg.
Agencies:
Aberdeen, Wash. — Grays Harbor Hardware Co.
Baltimore, Md.—The John B. Adt Co.
Baltimore, Md. — The New Era Elevator & Machine Co.
Baltimore, Md. — Shepherd-Fluharty Electric Co.
Bath, Me.—Frank A. Palmer.
Birmingham, Ala. — The Electric & Auto Supply Co.
Birmingham, Ala.—The Young & Vann Supply Co.
Biloxi, Miss.—W. O. Clark.
Boston, Mass. — Perrin, Seamans & Co.
Brooklyn, N. Y.—Brooklyn Electrical Supply Co.
Charleston, S. C.—J. J. W. Luden & Co.
Chattanooga, Tenn. — Rogers-Bailey Hardware Co.
Cincinnati, Ohio.—Cincinnati, Railway Supply Co.
Columbus, Ohio.—Avery & Loeb Electric Co.
El Paso, Tex. — Krakauer, Zork & Moyes, Successors, Inc.
El Paso, Tex.—J. E. Robertson & Co.
Hartford, Conn.—L. L. Ensworth & Son.
Huntington, W. Va.—The Miller Supply Co.
Indianapolis, Ind.—Indianapolis Electric Supply Co.
Jacksonville, Fla.—Geo. E. Chase & Co.
Jacksonville, Fla.—Ligingston Yonge Co.
Kansas City, Mo. — B-R Electric & Telephone Mfg. Co.
Los Angeles, Cal.—J. E. Robertson & Co.
Milwaukee, Wis.—Peter J. Soulen, Special Representative.
Mobile, Ala.—Mobile Ship Chandlery Co.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont.

New London, Conn.—The Darrow & Comstock Co.
New Orleans, La.—A. Baldwin & Co., Ltd.
New York, N. Y.—Braunfels, Browning & Co.
New York, N. Y.—Georg F. Grant Co., Inc.
Parkersburg, W. Va.—J. J. Crotty & Co.
Philadelphia, Pa.—Burrows Sloan & Co.
Philadelphia, Pa.—Lewis & Roth Co.
Pittsburgh, Pa. — W. T. McCullough Electric Co.
Portland, Ore.—Marshall-Wells Hardware Co.
Richmond, Va.—W. H. Jenks.
Richmond, Va.—Virginia Machinery & Well Co.
Rochester, N. Y.—Rochester Electrical Supply Co.
Savannah, Ga.—Savannah Ship Chandlery & Supply Co.
St. Louis, Mo.—The Continental Supply Co.
St. Louis, Mo.—The Wesco Supply Co.
Spokane, Wash. — Marshall-Wells Hardware Co.
Syracuse, N. Y.—Burhons & Black, Inc.
Syracuse, N. Y.—H. J. Gorke.
Utica, N. Y.—David S. Foster Sons & Co.
Utica, N. Y.—Porter Electric Co., Inc.
Washington, D. C.—Barber & Ross.
Washington, D. C.—Carroll Electric Co.
Wilmington, Del.—Delaware Electric & Supply Co.
Wilmington, Del.—Garrett, Miller & Co.
Wilmington, N. C.—Wilmington Iron Works.

HELLER & BRIGHTLY 76
S. E. Cor. Spring Garden and Ridge Avs., Philadelphia, Pa.

HENDRICK MFG. CO...............123
Carbondale, Pa.
Branch Offices:
Hazleton, Pa.—C. C. Boone.
New York, N. Y.—B. C. Guerin, 30 Church St.
Representatives:
Birmingham, Ala. — McCrossin Eng. Co., American Trust Bldg.
Chicago, Ill.—R. B. Clark, Jr., McCormick Building.
Chicago, Ill.—Carl L. Pettersen, Pioneer Press Bldg.
Denver, Colo.—James C. Dolan, 1617 Blake St.

HERCULES POWDER CO...740-741-742
Wilmington, Del.
Branch Offices:
Chicago, Ill.—332 So. Michigan Ave.
Denver, Colo.—317-319 Century Bldg.
Joplin, Mo.—Independent Bldg.
Hazleton, Pa.—2 Markle Bank Bldg.
New York, N. Y.—120 Broadway.
Pittsburg, Kan.—Commerce Bldg.
Pittsburgh, Pa.—Fulton Bldg.
Salt Lake City, Utah.—Kearns Bldg.
San Francisco, Cal.—Chronicle Bldg.
St. Louis, Mo.—1524 Pierce Bldg.
Subsidiary:
Hercules Powder Sales Co.. Bank of Commerce & Trust Bldg., Memphis, Tenn., and Knoxville, Tenn.

HESS-BRIGHT MFG. CO., THE....509
Front St. and Erie Ave., Philadelphia, Pa.

HEYL & PATTERSON, INC..........97
Pittsburgh, Pa.

HIGHLAND CHEMICAL PRODUCTS CO. 596
Connellsville, Pa.
Agents:
Chicago, Ill.—F. W. Priester, 4729 N. Troy St.
Kansas City, Mo.—Irving Smith Supply Co.
Scranton, Pa.—Francis H. Coffin Co., Board of Trade Bldg.

HOCKENSMITH WHEEL & MINE CAR CO................464-465
Penn Station, Pa.
Representatives:
Chicago, Ill.—Orenstein-Arthur Koppel Co., Peoples Gas Bldg.
Huntington, W. Va.—Huntington Supply & Equipment Co., Robson-Prichard Bldg.
Knoxville, Tenn.—Webster & Co., Holston Bank Bldg.
St. Louis, Mo. — Orenstein-Arthur Koppel Co., Railway Exchange Bldg.

HOFFMAN BROS. 67
Punxsutawney, Pa.

HOLMES, ROBERT, & BROS., INC. 378-379
Danville, Ill.
Agency:
Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

HOMESTEAD VALVE MANUFACTURING CO. 279
P. O. Box 1754, Pittsburgh, Pa.
Agencies:
Atlanta, Ga.—Seager-Walraven Co., 38 W. Alabama St.
Birmingham, Ala.—Young & Vann Supply Co., 1725 First Ave.
Boston, Mass.—Evans Mill Supply Co., 212 Summer St.
Buffalo, N. Y.—Root. Neal & Co., 178-180 Main St.
Buffalo, N. Y.—J. H. Ruckel & Son, 81 Main St.
Butte, Mont.—Western Mining Supply Co., 56 E. Broadway.
Chicago, Ill.—O. C. Keckley Co., 608 So. Dearborn St.
Cincinnati, O.—Queen City Supply Co., S. W. Cor Pearl and Elm Sts.
Cleveland, O.—W. M. Pattison Supply Co., 777 Rockwell Ave.
Dallas, Texas — Briggs-Weaver Machinery Co.
Denver, Colo.—Hendrie & Bolthoff Mfg. & Supply Co., 1621 Seventeenth St.
Detroit, Mich.—Kenneth Anderson Co., 33-41 East Atwater St.
El Paso, Texas—Lippincott, Beall & Co., 610 Mills Bldg.
Everett, Wash.—Lloyd Co., Cor. Hewitt & Grand Aves.
Fort Smith, Ark. — Meister Bros.-Bracht & Co., 201-203 S. Sixth St.
Fort Wayne, Ind.—National Mill Supply Co.
Fort Worth, Texas—Texas Mfg. Co.
Houston, Texas—F. W. Heitmann Co.
Indianapolis, Ind.—Indianapolis Belting & Supply Co., 34 S. Capitol Ave.
Jacksonville, Fla.—J. G. Christopher Co.
Joplin, Mo.—Joplin Supply Co.
Kansas City, Mo.—English Tool & Supply Co., 410 W. Fifth St.
Knoxville, Tenn.—Tennessee Mill & Mine Supply Co., 516 State St.
Little Rock, Ark.—Central Supply Co., 119 Scott St.
Los Angeles, Cal.—Smith-Booth-Usher Co., 238 Central Ave.
Louisville, Ky.—E. D. Morton & Co., 516 W. Main St.
Marshalltown, Iowa—Kiowa Sales Co.
Memphis, Tenn.—N. O. Nelson Co.
Minneapolis, Minn.—Power Equipment Co., 212 Third Ave., N.
New Orleans, La. — Woodward-Wight & Co.
New York, N. Y.—Frank Boyle, 428 Park Row Bldg.
Omaha, Neb.—United States Supply Co., Ninth and Farnam Sts.
Oklahoma City, Okla.—Mideke Supply Co., 304 West First St.
Philadelphia, Pa.—Brogan & Co., 810 Race St.
Portland, Ore.—Pacific Asbestos & Supply Co., 308 Glisan St.
Portland, Me.—W. L. Blake & Co., 79 Commercial St.
Providence, R. I.—E. M. Dart Mfg. Co., 136 Clifford St.
Rochester, N. Y.—General Power Specialties, 305 Chamber of Commerce Bldg.
St. Louis, Mo.—Geo. T. Matthews & Co., 20 S. Main St.
Salt Lake City, Utah—Galigher Machinery Co.
San Antonio, Texas—San Antonio Machinery Co.
San Francisco, Cal.—W. E. Mushet Co., 502 Mission St.
Seattle, Wash.—Steam Supply & Rubber Co., 79 Washington St.
Springfield, Mass.—Wyckoff & Lloyd Co., Myrick Bldg.
Tacoma, Wash.—Walsh & Gardner, Pacific Ave.
Tampa, Fla.—Cameron & Barkley.
Toledo, O.—Standard Mfg. Co., 311-321 Erie St.

HOUSTON, STANWOOD & GAMBLE CO. 229
Cincinnati, Ohio.

HOWELLS MINING DRILL CO.....626
Plymouth, Pa.

HUGHES BROTHERS 756
Scranton, Pa.

HUNTER PRESSED STEEL COMPANY 283
Philadelphia, Pa.

HUNTINGTON LUMBER & SUPPLY COMPANY 188
Huntington, W. Va.
Branch Office:
Pittsburgh, Pa. — L. Brandt, Park Bldg.

HYATT ROLLER BEARING CO....478
Newark, N. J.

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ILG ELECTRIC VENTILATING COMPANY 347
Chicago, Ill.
Branch Offices:
Boston, Mass. — Tompkins-Stoddard Co., 136 Federal St.
Cleveland, O.—1314 Schofield Bldg.
Detroit, Mich.—Wm. L. Ruttledge, 724 Penobscot Bldg.
New York, N. Y.—13 Park Row.
Philadelphia, Pa.—327 Commercial Trust Bldg.
Pittsburgh, Pa.—559 Union Arcade Bldg.

ILLINOIS POWDER MANUFACTURING COMPANY 744
St. Louis, Mo.
Agencies:
Chicago, Ill.—Ed. C. Rice, 28 E. Jackson Bl.
Cleveland, O.—The Austin Powder Co.
Pittsburg, Kan.—Geo. B. Watkins.

IMPERIAL BRASS MFG. CO.....707
1200 West Harrison St., Chicago, Ill.
Branch Offices:
New York, N. Y.—C. L. Newkom, 51 E. 42nd St.
San Francisco, Cal.—A. J. Buckley, 530 Monadnock Bldg.

INDIANA FOUNDRY CO., LTD...516
Indiana, Pa.

INDIANAPOLIS SWITCH & FROG CO., THE 437
Springfield, O.
Branch Offices:
Chicago, Ill. — 1528-29 McCormick Bldg.
Philadelphia, Pa.—4401 Walnut St.

INGERSOLL-RAND CO....256-257-622
11 Broadway, New York, N. Y.
Branch Offices:
Birmingham, Ala.—H. M. Perry, Mgr., American Trust Bldg.
Boston, Mass.—R. K. Swift, Mgr., 32 Oliver St.
Buffalo, N. Y.—114 Claremont Ave.
Butte, Mont.—R. W. Rusterholz, Mgr., 109 E. Broadway.
Chicago, Ill.—M. P. Frutchey, Mgr., Peoples Gas Bldg.
Cleveland, O.—W. A. Armstrong, Mgr., Williamson Bldg.
Denver, Colo. — Stearns-Roger Mfg. Co., 1718 California St.
Duluth, Minn.—S. H. Hill, Mgr., Providence Bldg.
El Paso, Tex.—J. D. Foster, Mgr., 121 San Francisco St.
Houghton, Mich. — Thos. F. Lynch, Mgr., Citizens Natl. Bank Bldg.
Joplin, Mo.—111 West Third St.
Knoxville, Tenn. — L. F. Thompson, Mgr., Holston Natl. Bank Bldg.
Los Angeles, Cal. — W. Blackburn, Mgr., 1035 Union Oil Bldg.
Mexico City, Mex.—Cadena No. 2.
New Orleans, La. — Hibernia Bank Bldg.
Philadelphia, Pa.—Phil. Weiss, Mgr., Commercial Trust Bldg.
Pittsburgh, Pa.—W. F. Gilles, Mgr., Farmers Bank Bldg.
Scranton, Pa. — Dime Savings Bank Bldg.
St. Louis, Mo.—D. M. Armstead, Mgr., 300 N. Broadway.
Salt Lake City, Utah.—J. W. Mossmon, Mgr., 210 S. W. Temple St.
San Francisco, Cal.—H. L. Terwilliger, Mgr., 139 Townsend St.
Seattle, Wash.—J. J. Kennedy, Mgr., Colman Bldg.
Washington, D. C.—Fred S. Hardesty, Riggs Bldg.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont.

INTERNATIONAL CONVEYOR CORP. 102
50 E. 42nd St., New York, N. Y.

INTERSTATE EQUIPMENT CORP. 399
10 Wall St., New York, N. Y.
(Factory, Roanoke, Va.)

IRON CITY ELECTRIC COMPANY 675
436 7th Ave., Pittsburgh, Pa.
Representatives:
Cumberland, Md.—C. W. White, 86 Decatur St.
Irwin, Pa.—R. C. Murdoch, Pennsylvania Ave.
New Castle, Pa.—J. W. Disbrow, 605 Highland Ave.
New Kensington, Pa.—W. M. Kline, 1135 Kenneth Ave.

IRONSIDES COMPANY, THE 412
Columbus, Ohio.

IRONTON ENGINE COMPANY, THE 492
Ironton, Ohio.
District Offices:
Belleville, Ill.—Homer Greer.
Birmingham, Ala.—Keiser - Geismer Engineering Co.
Columbus, Ohio—L. A. Starrett.
Philadelphia, Pa.—Harry W. Faunt Le Roy, 1211 Fidelity Mutual Bldg., Eastern Representative.
Pittsburgh, Pa.—M. W. Scott, Mgr., 2138 Oliver Bldg.

IRWIN FOUNDRY & MINE CAR CO. 463
Irwin, Pa.
Agency:
Welch, W. Va.—S. H. Ihmsen, Box 273.

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JACOBSEN & SCHRABDER, INC. 98
Marquette Bldg., Chicago, Ill.

JAMES, EDWARD F., SALES CO. 780
803 Markle Bank Bldg., Hazleton, Pa.
Agencies:
Apalache, Va. — Virginia Wholesale Co.
Ashland, Ky.—Ben Williamson Hardware Co.
Altoona, Pa. — Standard Supply & Equipment Co.
Bluefield, W. Va.—Bluefield Hardware Co.
Charleston, W. Va. — Charleston Hardware Co.
Donaldsville, La.—B. Lehman & Bro.
Greensburg, Pa.—Probst & Son.
Logan, W. Va.—Logan Hardware Co.
Norton, Va.—Norton Hardware Co.
Uniontown, Pa.—W. D. Ghrist.

JEFFREY MFG. CO., THE....100-101-127-339-340-341-488-489-612-613
962 N. Fourth St., Columbus, O.
Branch Offices:
Birmingham, Ala. — C. M. Blanchard, Mgr., Brown-Marx Bldg.
Chicago, Ill.—S. S. Shive, Mgr.; Geo. B. Ellstrom, C. C. Ford, 1807 McCormick Bldg.
Cleveland, O.—W. E. Holloway, C. B. Reed, 421-423 Rockefeller Bldg.
Denver, Colo.—Frank R. Field, Mgr.; E. C. Horne, C. M. Goddard, First National Bank Bldg.
Dallas, Tex.—J. U. Jones, Mgr., Commonwealth Bank Bldg.
Middlesboro, Ky.—J. L. Moore.
Milwaukee, Wis.—A. Q. Dufour, Mgr., M. & M. Bldg.
New York, N. Y.—F. C. Ayers, Mgr., W. C. Miller, J. B. Noros, 50 Dey St.
Philadelphia, Pa.—J. G. Ogden, Mgr., Real Estate Trust Co.
Pittsburgh, Pa. — W. W. Woodruff, Mgr.; C. H. Fisher, J. H. McKinley, Farmers Bank Bldg.
St. Louis, Mo.—W. V. Cullen, Mgr., Room A-21 Railway Exchange Bldg.
Scranton, Pa.—J. W. White, Mgr., 518 Union Natl. Bank Bldg.
Seattle, Wash.—P. E. Wright, Mgr., L. C. Smith Bldg.
Canadian Office:
Montreal, Que., Can.—M. W. Sherwood, Mgr., Power Bldg.
Protected Agents:
Atlanta, Ga.—Cotton States Belting & Supply Co.
Baltimore, Md. — Carey Machinery & Supply Co.
Boston, Mass.—H. C. Freeman & Co., 141 Milk St.
Buffalo, N. Y.—Hendee-Connor Co.
Cedar Rapids, Ia.—Cedar Rapids Pump Co.
Charleston, S. C.—Bailey-Lebbey Co., Meeting St.
Charleston, W. Va.—Charleston Electrical Supply Co.
Cincinnati, O.—Wirthlin-Mann Co.
Cleveland, O. — Strong, Carlisle & Hammond Co.
Fort Smith, Ark.—Meister Brothers-Bracht Co.
Fort Worth, Tex.—Texas Mfg. Co.
Houston, Tex.—Peden Iron & Steel Co.
Indianapolis, Ind.—Indianapolis Belting & Supply Co.
Jacksonville, Fla.—Georgia Supply Co.
Louisville, Ky.—W. H. Neill Co.
Kansas City, Mo.—Gustin Bacon Mfg. Co.
Memphis, Tenn. — Reichman-Crosby Co.
Minneapolis, Minn.—Frank J. Rose Co.
Montgomery, Ala.—Alabama Machinery & Supply Co.
Nashville, Tenn.—Keith-Simmons Co.
New Bern, N. C.—Hyman Supply Co.
New Orleans, La.—A. M. Lockett & Co.
Norfolk, Va.—Henry Walke Co.
Richmond, Va.—Smith-Courtney Co.
St. Louis, Mo.—Crickwell Mine & Mill Supply Co.
Salt Lake City, Utah.—R. J. Glendenning & Co.
San Francisco, Cal.—General Machinery & Supply Co.
Savannah, Ga.—Georgia Supply Co.
Syracuse, N. Y.—Syracuse Supply Co.
Troy, N. Y.—Tolhurst Machine Works.
Wilmington, N. C. — Hyman Supply Co.
Agents Not Protected:
Fort Wayne, Ind.—National Mill Supply Co.
Macon, Ga.—Schofield Sons Co.
Little Rock, Ark.—Central Supply Co.
Mobile, Ala. — McGowan-Lyons Hdwe Co.
Mulberry, La.—Mine & Mill Supply Co.
New Orleans, La.—Fairbanks Co.
Portland, Ore.—Portland Machinery & Supply Co.
St. Mary's, O.—Jasperson Supply Co.
Toledo, O.—Standard Mfg. Co.
Washington, N. C.—McKeel-Richardson Hdwe. Co.

JENKINS BROS. 280
80 White St., New York, N. Y.
Branch Offices:
Boston, Mass.—524 Atlantic Ave.
Chicago, Ill.—300 West Lake St.
Philadelphia, Pa.—133 No. Seventh St.

JOHNS, H. W.-MANVILLE CO.....182
Madison Ave. and Forty-first St., New York, N. Y.
Akron, O.—717 Second Natl. Bank Bldg.
Albany, N. Y.—260 Central Ave.
Atlanta, Ga.—31-A So. Broad St.
Baltimore, Md.—207-213 E. Saratoga St.
Birmingham, Ala. — 819 American Trust Bldg.
Boston, Mass.—55-61 High St., H. R. Trainer, Mgr.
Buffalo, N. Y.—206-208 Main St., T. T. Lyman, Mgr.
Cincinnati, O.—654-656 Main St.
Cleveland, O.—813-15 Superior Ave., N. W., Harry Gillett, Mgr.
Columbus, O.—45 West Long St.
Dallas, Tex.—2008-10 Commerce St.
Dayton, O.—604 Schwind Bldg.
Denver, Col.—533-558 Denver Gas & Elec. Bldg.
Des Moines, Ia.—911 Walnut St.
Detroit, Mich.—72 Jefferson Ave.
Duluth, Minn.—327 West First St.
El Paso, Tex.—1104 Mills Bldg.
Grand Rapids, Mich.—Builders and Traders Exchange.
Great Falls, Mont.—418 Ford Bldg.
Havana, Cuba.—Aguiar 116.
Houghton, Mich.—Murphy Bldg.
Houston, Tex.—304 Texas Co. Bldg.
Indianapolis, Ind. — 408-410 North Capitol Ave.
Kansas City, Mo.—1514 Grand Ave.
Los Angeles, Cal.—1232 So. Grand Ave.
Louisville, Ky.—4th Ave. and Guthrie St.
Memphis, Tenn.—274 Monroe St.
Milwaukee, Wis.—201-231 Claybourn St.
Minneapolis, Minn.—18 So. Eighth St.
Montreal, Que.—450-452 St. James St.
New Orleans, La.—Cor. Magazine and Gravier Sts.
Newark, N. J.—239 Halsey St.
Omaha, Neb.—1003 Farnam St.
Philadelphia, Pa.—210 N. Broad St., E. Searing, Mgr.
Pittsburgh, Pa.—100-102 Wood St., A. G. Cutting, Mgr.
Portland, Ore.—69 Broadway.
Rochester, N. Y.—521 Chamber of Commerce.
Sacramento, Cal.—1015 Tenth St.
St. Louis, Mo.—501-505 N. Third St., W. G. Klauss, Mgr.
St. Paul, Minn.—420 Mer. Nat. Bank Bldg., 4th and Roberts Sts.
Salt Lake City, Utah.—408-10 Dooley Block.
San Diego, Cal.—414 E. St.
San Francisco, Cal. — Second and Howard Sts., W. S. Greenfield, Mgr.
Seattle, Wash.—Third Ave. and Stewart St., D. W. Boylan, Mgr.
Syracuse, N. Y.—344 Gurney Bldg.
Toledo, O.—237 Erie St.
Toronto, Ont.—19 Front St., East, W. M. Hiller, Mgr.
Tulsa, Okla.—308 Unity Bldg.
Vancouver, B. C.—511 Winch Bldg.
Washington, D. C.—Builders and Mfrs. Exchange Bldg.
Wilkes-Barre, Pa. — Coal Exchange Bldg.
Winnipeg, Man.—385 Portage Ave.
Youngstown, O. — 502 Stambaugh Bldg.

JOHNSTON-MOREHOUSE-DICKEY CO. 357
Pittsburgh, Pa.

JOYCE-CRIDLAND COMPANY, THE 778
315-351 South Linden Ave., Dayton, O.
Branch Offices and Agencies:
Chicago, Ill.—Crerar, Adams & Co.
Cincinnati, O.—E. A. Kinsey Co.
Claremont, N. H.—Sullivan Machinery Co.
Cleveland, O.—W. M. Pattison Supply Co.
Columbus, O.—Columbus Mill & Mine Supply Co.
Los Angeles, Cal.—C. Appelhoff.
Louisville, Ky.—Belknap Hardware & Mfg. Co.
New York, N. Y.—A. Z. Boyd, 126 Chambers St.
Pittsburgh, Pa.—Pittsburgh Gage & Supply Co.
Pittsburgh, Pa.—C. A. Turner, Inc.
St. Louis, Mo.—F. E. Palmer Supply Co.

JUSTRITE MFG. CO...............760
2061-2081 Southport Ave., Chicago, Ill.

K

K-B PULVERIZER CO., INC........128
86 Worth St., New York, N. Y.
Agencies:
Atlanta, Ga.—Henry G. Williams, Third National Bank Bldg.
Baltimore, Md.—Maryland Equipment & Supply Co., Equitable Bldg.
Louisville, Ky.—Brandeis Machinery & Supply Co.
Philadelphia, Pa.—Chas. M. Conner, 502 North 19th St.

KANAWHA MFG. CO...........103-468
Charleston, W. Va.

KEASBEY & MATTISON CO. 183
Ambler, Pa.
Branch Offices and Agents:
Atlanta, Ga.—Clayton S. Berry, 46 Fairlie St.
Baltimore, Md.—Chesapeake Rfg. & Pipe Covg. Co., 117 Cheapside.
Baltimore, Md.—Wallace & Gale, 115 S. Gay St.
Boston, Mass.—186 Purchase St.
Buffalo, N. Y.—17 Terrace.
Chattanooga, Tenn.—Porter Warner, Room 320 Hamilton Natl. Bank.
Chicago, Ill.—222-24 W. Lake St.
Cincinnati, O.—528 Main St.
Cleveland, O.—513-14 American Trust Bldg.
Denver, Colo.—W. S. Core, 211 Ideal Bldg.
Detroit, Mich.—S. P. Conkling, 68 Jefferson Ave.
Houston, Tex.—521 Beatty Bldg.
Indianapolis, Ind. — Lemcke Bldg., Thru Cincinnati.

List of Firms Catalogued, Branch Offices Representatives and Agencies---Cont

Jackson, Miss. — Jackson Lumber Company.
Kansas City, Mo.—R. V. Aycock & Co., 1702 Grand Ave.
Minneapolis, Minn.—427-29 Washington Ave., N.
New Orleans, La.—J. T. Mann & Co., 909 Union St.
New York City, N. Y.—217 Broadway.
Philadelphia, Pa.—1927-29 Market St.
Pittsburgh, Pa.—Monongahela House, 339 Water St.
St. Louis, Mo.—105 Main St. .
Salt Lake City, Utah—T. A. Williams, 211-15 Scott Bldg.
San Francisco, Cal.—J. A. Drummond, 245 Mission St.
Steelton, Pa.—Geo. L. Merryman.
Syracuse, N. Y.—319 Seitz Bldg.
Washington, D. C.—1111 Fourteenth St., N. W.
Wilkes-Barre, Pa.—W. E. Steelman Company, 85 N. Main St.

KEELER, E. CO., THE............230
Williamsport, Pa.
Agencies:
Boston, Mass. — Widger-Miller Co., 141 Milk St.
Chicago, Ill.—Keeler, E., Co., 1409 Harris Trust Bldg.
New Orleans, La.—A. Baldwin, Ltd.
New York, N. Y.—Keeler, E., Co., Room 1878, 50 Church St.
Philadelphia, Pa.—Keeler, E., Co., 1518 Real Estate Trust Bldg.
Pittsburgh, Pa.—Keeler, E., Co., 905 Commonwealth Bldg.
Portland, Ore. — Power Equipment Co., 816-17 Lewis Bldg.
Richmond, Va.—J. L. Lindsay, Inc., 1321 Main St.
Richmond, Va. — Hawkins-Hamilton Co., American National Bank Bldg.
Rochester, N. Y. — Strong-Hery Co., 301-307 State St.
Seattle, Wash.—Power Equipment Co., Central Bldg.

KERR TURBINE COMPANY......254
Wellsville, N. Y.
Branch Offices:
Atlanta, Ga.
Birmingham, Ala.
Boston, Mass.
Charlotte, N. C.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Detroit, Mich.
Houston, Tex.
Indianapolis, Ind.
Kansas City, Mo.
Memphis, Tenn.
Minneapolis, Minn.
New Orleans, La.
New York, N. Y.
Omaha, Neb.
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Ore.
St. Louis, Mo.
Salt Lake City, Utah.
San Francisco, Cal.
Seattle, Wash.
Sherman, Tex.
Washington, D. C.
Winnipeg, Mo.
Canadian Offices:
Montreal, Can.; Toronto, Ont., Can.; Vancouver, B. C., Can.

KESTER ELECTRIC CO., THE....676
Terre Haute, Ind.

KETTLE RIVER CO., THE........170
Minneapolis, Minn.
Distributors:
Beaumont, Tex.—E. L. Wilson Hardware Co.
Chicago, Ill.—James A. Kenny, Webster Bldg.
Cleveland, O.—C. H. Hoyt, 412 Citizens Bldg.
Louisville, Ky. — J. B. Wilkinson, Starks Bldg.
New Orleans, La.—C. T. Patterson Co., Ltd., 801 Tchoupitoulas St.
New York, N. Y.—American Chemical & Mfg. Co., 149 Broadway.
Norfolk, Va.—American Chemical & Mfg. Co.
Pittsburgh, Pa.—Monongahela Wood Preserving Co., Fulton Bldg.
Portland, Ore.—W. W. Gordon & Co., Ainsworth Bldg.
St. Louis, Mo.—F. A. Bobel, 1002 Title Guarantee Bldg.
San Francisco, Cal.—C. H. Johnson, Rialto Bldg.

KEYSTONE LUBRICATING CO....302
Philadelphia, Pa.
Branch Offices:
Boston, Mass.—141 Milk St.
Chicago, Ill.—3633-39 So. Racine Ave.
Denver, Colo.—First Natl. Bank Bldg.
New York, N. Y.—1777 Broadway.
New Orleans, La.—609 Chartres St.
Philadelphia, Pa. — Twenty-first and Clearfield Sts.
Pittsburgh, Pa.—Jenkins Arcade Bldg.
San Francisco, Cal.—268 Market St.
Savannah, Ga.—411 Real Estate Bldg.

KILBY FROG & SWITCH CO......438
Birmingham, Ala.

KINK POWDER CO., THE........745
Cincinnati, O.
Agency:
Charleston, W. Va.—Lewis, Hubbard & Co.

KREHBIEL COMPANY 99
1712 Marquette Bldg., Chicago, Ill.

L

LAKE SHORE ENGINE WORKS..630
Marquette, Mich.

LAKEWOOD ENGINEERING CO., THE 493
Cleveland, O.
Branch Offices and Agents:
Boston, Mass.—Harold L. Bond Co., 383 Atlantic Ave.
Chattanooga, Tenn.—C. Turner Company, 523 James Bldg.
Chicago, Ill.—The Lakewood Engineering Co., 506 S. Canal St.
Cincinnati, O.—George B. Curd, 801 Mercantile Library Bldg.
Cleveland, O.—W. M. Pattison Supply Co., 211 St. Clair St.
Detroit, Mich.—Geo. T. Wallace Sales Co., 400 Penobscot Bldg.
El Paso, Tex.—Krakauer, Zork & Moye's Suc., Inc.
Fort Worth, Tex.—A. S. Goetz, 504 F. & M. Bk. Bldg.
Louisville, Ky.—Roy C. Whayne Supply Co., 318 W. Main St.
Milwaukee, Wis.—Kern-Hunter Inc., 208 Wells St.
New York City, N. Y.—The Lakewood Engineering Co., 30' Church St., Room 940. (Messrs. Brown & Sites.)
New York City, N. Y.—Allied Construction Mach Corp'n, 120 Broadway.
Oklahoma City, Okla.—J. S. Wylie Co., 711 Majestic Bldg.
Philadelphia, Pa.—The Lakewood Engineering Co., 1034 Widener Bldg.
Pittsburgh, Pa.—F. H. Robinson, 426 Fulton Bldg.
Rochester, N. Y.—H. D. Hutcheson Co., 111 Sibley Block.

LAWRENCE, W. W. & COMPANY..171
Pittsburgh, Pa.
Representatives:
Altoona, Pa.—K. R. Hosey, 1723 16th St.
Altoona, Pa.—H. T. Shick, 413 Green Terrace.
Cleveland, O.—C. W. Cadle, 483 E. 123rd St.
Columbus, O.—C. W. Stansbury, 115 W. 2nd Ave.
Glendale, W. Va.—F. D. Walker.
Pittsburgh, Pa.—George Barnett, 717 Liberty Ave.
Pittsburgh, Pa.—D. F. Keenan, West Carson St.

LAZARUS, M. E., CO., THE......432
1244 Rockefeller Bldg., Cleveland, O.

LEADITE COMPANY, INC., THE..595
1406 Chestnut St., Philadelphia, Pa.

LEETONIA TOOL COMPANY.....799
Leetonia, O.
Agencies:
Birmingham, Ala.—John D. Turner Co., Jefferson County Bank Bldg.
Knoxville, Tenn.—P. K. Arrington & Co.
Nashville, Ill.—J. H. Lamar.
Canadian Agency:
Winnipeg, Can.—F. G. Maxwell & Co., 201 Union Bank Bldg.

LEHIGH PORTLAND CEMENT COMPANY 158
Young Bldg., Allentown, Pa.

LESCHEN, A., & SONS ROPE CO..404
Hamilton and Kennerly Aves.,
St. Louis, Mo.
Branch Offices:
New York Store—87-90 West St.
Chicago Store—171-173 West Lake St.
Denver Store—1645-1647 Wazee St.
Salt Lake Store—921 Kearns Bldg.
San Francisco Store — Monadnock Bldg.

LE VALLEY-VITAE CARBON BRUSH CO. 669
521 West 23rd St., New York, N. Y.
Sales Offices:
Birmingham, Ala. — McClary-Jemison Machinery Co., 3 South 20th St.
Cleveland, O.—Edward S. Ford, 11 Wade Bldg.
Huntington, W. Va.—C. C. McGuire, Hotel Huntington.
New Orleans, La.—John S. Black, 7928 Zimple St.
Pittsburgh, Pa.—Wm. D. Stevenson, 608 Comomnwealth Bldg.

LIDGERWOOD MFG. CO.......380-381
96 Liberty St., New York, N. Y.
Branch Offices:
Chicago, Ill.—Fisher Bldg.
Los Angeles, Cal.—1106 Hibernian Bldg.
Philadelphia, Pa.—Widener Bldg.
Pittsburgh, Pa.—Union Bank Bldg.
Seattle, Wash.—63-5 Columbia St.

LIFE SAVINGS DEVICES CO.....769
565 W. Monroe St., Chicago, Ill.
New York, N. Y.—Life Saving Devices Co., 1107 Times Bldg.

LIGHT RAILWAY EQUIPMENT COMPANY 442
526 Commercial Trust Bldg.,
Philadelphia, Pa.
Branch Offices:
Chester, Pa.—5th and Ward Sts..
Pittsburgh, Pa.—Federal Engineering Co., 1116 House Bldg.

LINK-BELT COMPANY 104-352
39th St. and Stewart Ave., Chicago, Ill.
Dodge Works: West Michigan St. and Holmes Ave., Indianapolis, Ind.
Ewart Works and Belmont Foundry: Belmont Ave. and "Pennsylvania" and "Big Four" tracks, Indianapolis, Ind.
Philadelphia, Pa.—P. & R. Ry. and Hunting Park Ave.
Branch Offices:
Boston, Mass.—49 Federal St.
Buffalo, N. Y.—698 Ellicott Square.
Cleveland, O.—429 Rockefeller Bldg.
Detroit, Mich.—732 Dime Bank Bldg.
Kansas City, Mo.—407 Finance Bldg.
Los Angeles, Cal.—161 N. Los Angeles St.
Minneapolis, Minn.—418 S. Third St.
New York, N. Y.—299 Broadway.
Pittsburgh, Pa.—1501-2 Park Bldg.
Portland, Ore.—First and Stark Sts.
St. Louis, Mo. — Central Natl. Bank Bldg.
San Francisco, Cal.—461 Market St.
Wilkes-Barre, Pa.—Second Natl. Bank
Seattle, Wash.—580 First Ave., S.
Wilkes-Barre, Pa.—Second Natl Bank Bldg.
Sales Offices:
Birmingham, Ala.—McCrossin & Darrah, Am. Trust Bldg.
Denver, Colo.—Lindrooth, Shubart & Co., Boston Bldg.
Knoxville, Tenn.—D. T. Blakey, 704 Empire Bldg.
Louisville, Ky.—Frederick Wehle, 1121 Starks Bldg.
New Orleans, La. — C. O. Hinz, 612 Hibernia Bank Bldg.
Canadian Branch:
Toronto, Que., Can.—Canadian Link-Belt Co., Ltd.

LITCHFIELD FOUNDRY & MACHINE CO. 383
Litchfield, Ill.

LOBDELL CAR WHEEL CO...466-467
Wilmington, Del.
Branch Office:
New York, N. Y.—G. S. Thompson, Mgr., 6 Church St.
Representatives:
Bluefield, W. Va.—F. M. Archer,
Norton, Va.—Norton Electric Supply & Equipment Co.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont.

LUITWEILER PUMPING ENGINE COMPANY 577
123 Ames St., Rochester, N. Y.
Branch Offices:
Cleveland, O.—F. H. Kelliher, 316 Perry Paine Bldg.
Los Angeles, Cal.—Luitwieler Pumping Engine Co., 707 North Main St.
Agencies:
Boston, Mass.—Lunt-Moss Co., 43 South Market St.
Buffalo, N. Y.—W. P. Drake, 290 Riley Ave.
Chattanooga, Tenn.—James Supply Co.
Dallas, Tex.—Briggs-Weaver Machine Co.
El Paso, Tex.—Karkauer, Zock & Moye Co.
Houston, Tex.—Southern Engine & Pump Co.
Jacksonville, Fla.—J. P. Campbell.
Joplin, Mo.—Gregg Pump Co.
Kansas City, Mo.—Merkle Machinery Co.
Kingman, Ariz.—Axel Ericson.
Knoxville, Tenn.—Webster & Co.
Marion, Ky.—A. H. Reed.
New York, N. Y.—David Garvey, 26 Cortlandt St.
Omaha, Neb. — Merkle-Hines Machinery Co.
Pittsburgh, Pa.—F. W. Rockstroh, First Natl. Bank Bldg.
Richmond, Va.—Sydnor Pump & Well Co.
St. Louis, Mo.—A. L. Abbott, 122 North Seventh St.
San Diego, Cal.—C. B. Stern.
San Francisco, Cal.—Simonds Machinery Co.
Santa Barbara, Cal.—H. L. Osborne, Hard-Canfield Bldg.
Spokane, Wash.—Halladie Co.
Syracuse, N. Y.—M. P. Specialties Co.
Terre Bella, Cal.—Terra Bella Garage.
Tucson, Ariz.—Schweitzer Machine Co.
Wooklake, Cal.—Frederic Kitchener.
Canadian Agency:
West Toronto, Ont.—General Machinery Co.

LYNCHBURG FOUNDRY CO...588-589
Lynchburg, Va.
General Sales Office:
Chicago, Ill.—Peoples Gas Bldg.
Branch Sales Offices:
Dallas, Tex.
Los Angeles, Cal.
Portland Ore.
Tacoma, Wash.

Mc

McABEE, G R. POWDER & OIL COMPANY 743
Second National Bank Bldg., Pittsburgh, Pa.
Agencies:
Cattlesburg, Ky.—Ben Williamson & Co.
Wilsonburg, W. Va.—Long Powder & Supply Co.

McCLAVE-BROOKS CO............240
Scranton, Pa.
Branch Offices:
New York, N. Y.—S. C. Smith, Room 351, 50 Church St.
Boston, Mass.—A. R. St. John, Rooms 409-410, 261 Franklin St.
Chicago, Ill.—F. G. Smith, 515 Hearst Bldg.
Philadelphia, Pa.—Geo. Blair, Jr., 34 N. Woodlawn Ave., Aldan, Del. Co. (suburb of Philadelphia).
Buffalo, N. Y. — M. E. Henshaw, 55 Laurel St.
Southern Representative:
New Orleans, La.—Chas. Gruneberg, 425 Gravier St.

McCORD MANUFACTURING COMPANY, INC..................284
Detroit, Mich.
Branch Offices:
Chicago, Ill.—Peoples Gas Bldg.
New York, N. Y.—165 Broadway St.
Representatives:
Baltimore, Md.—Morton, McI. Dukehart & Co., 100-102 W. Fayette St.
Boston, Mass.—Paul R. Hodges, 727 Atlantic Ave.
Chicago, Ill.—H. A. McCord, 332 Monadnock Block.
Detroit, Mich.—Kenneth Anderson, Co., 33 East Atwater St.
Milwaukee, Wis.—I. W. Downing, 2431 Cold Springs Ave.
Minneapolis, Minn.—L. E. Pollard Co., 208 Iron Exchange Bldg.
New York, N. Y.—Pitts & Kitts Mfg. & Supply Co., Woolworth Bldg.
Philadelphia, Pa.—National Supply & Equipment Co., Bulletin Bldg.
Pittsburgh, Pa.—Joseph Cawley, Ferguson Bldg.
Richmond, Va.—Eastern Coal & Export Corp., First National Bank Bldg.
St. Paul, Minn.—George M. Kenyon, Pioneer Press Bldg.
San Francisco, Cal.—J. F. Hedden, 348 Monadnock Bldg.
Seattle, Wash.—E. Kelly, 1201 L. C. Smith Bldg.
Sherman, Tex.—Hardwicke-Etter Co.
Shreveport, La. — Gossett-Haywood Co., 318 Ward Bldg.
Canadian Representatives:
Montreal, Quebec—The Holden Co., Limited, 350 St. James St.
Toronto, Ontario—W. A. Buchanan, Traders Bank Bldg.

McCOY-BRANDT MACHINERY CO. 695
Pittsburgh, Pa.

McCULLOUGH, W. T., ELECTRIC COMPANY 677
2315 Penn Ave., Pittsburgh, Pa.

McKAY, JAMES, COMPANY.......479
Pittsburgh, Pa.
Branch Offices:
Chicago, Ill.—Ellsworth Bldg.
New York, N. Y.—30 Church St.
Agents:
Birmingham, Ala. — Keiser-Geismer Engr. Co.
Charleston, W. Va.—Kanawha Mfg. Co.

M

MACBETH-EVANS GLASS COMPANY 757
Pittsburgh, Pa.
Branch Offices:
Boston, Mass.—60 High St.
Buffalo, N. Y.—Mutual Life Bldg.
Chicago, Ill.—159-161 West Lake St.
Cincinnati, O.—Pickering Bldg.
Cleveland, O.—1900 Euclid Bldg.
New York—The Berkeley Bldg.
Philadelphia, Pa.—1613 Chestnut St.
Pittsburgh, Pa.—Chamber of Commerce Bldg.
San Francisco, Cal.—Rialto Bldg.
St. Louis, Mo.—Laclede Gas Light Bldg.
Canadian Office:
Toronto, Ont.—Macbeth-Evans Glass Company, Ltd., 160 Bay St.

MACOMBER & WHYTE ROPE CO. 405-480
Kenosha, Wis.
Branch Offices:
Chicago, Ill.—507 So. Clinton St.
Pittsburgh, Pa.—424 First Ave.
Portland, Ore.—235 Pine St.
Agencies:
Atlanta, Ga.—Fulton Supply Co.
Atlanta, Ga.—W. E. Austin Machinery Co.
Baltimore, Md.—John C. Louis.
Bay City, Mich.—Alert Pipe & Supply Co.
Bloomington, Ind.—Seward & Co.
Buffalo, N. Y.—The Neal Co.
Butler, Pa.—Spang & Co.
Charlotte, N. C.—General Mill Supply Co.
Chicago, Ill.—Macomber & Whyte Rope Co.
Cincinnati, O.—J. R. Wood Supply Co.
Columbus, O.—The Franklin Building Supply Co.
Dayton, O.—M. D. Larkin Supply Co.
Denver, Colo.—S. G. Elbe.
Detroit, Mich.—United Forge & Machine Co.
Duluth, Minn.—National Iron Co.
Erie, Pa.—H. P. Weller Supply Co.
Findlay, O.—Ohio Pipe Co.
Fort Smith, Ark. — Meister Bros. Bracket Co.
Havana, Cuba—Quinones Hardware Corp.
Hazard, Ky.—Sterling Hardware Co.
Helena, Ark.—Helena Hardware Co.
Huntington, W. Va. — Huntington Supply & Equipment Co.
Joplin, Mo.—McNeal Machinery Co.
Kansas City, Mo.—Kansas City Elev. Mfg. Co.
Kansas City, Mo.—Kansas City Steel Products Co.
Kenosha, Wis.—Macomber & Whyte Rope Co.
Kittanning, Pa.—Louden & Smith Co.
Knoxville, Tenn.—W. J. Savage & Co.
Lansing, Mich.—A. T. Vandervoort.
Little Rock, Ark.—C. E. Rosebaum Machinery Co.
Louisville, Ky.—Todd Donigan Iron Co.
Macon, Ga.—Taylor Iron Works & Supply Co.
Marietta, O.—Producers' Supply & Tool Co.
Middlesboro, Ky.—E. L. Rennebaum.
Milwaukee, Wis.—H. F. Evans.
Milwaukee, Wis. — Phillip Gross Hardware Co.
New Orleans, La.—Whitney Supply Co.
Pittsburgh, Pa.—Macomber & Whyte Rope Co.
Pittsburgh, Pa.—Pittsburgh Gage & Supply Co.
Platteville, Wis.—The Dana Co.
Portland, Ore.—Macomber & Whyte Rope Co.
Richmond, Va.—James McGraw, Inc.
Roanoke, Va.—H. W. Davant.
Saginaw, Mich.—Saginaw Hardware Co.
Scranton, Pa.—Chas. B. Scott Co.
St. Cloud, Minn. St. Cloud Iron Works.
St. Joseph, Mo.—Jamieson Machine Co.
St. Louis, Mo.—H. P. Webb Co.
St. Paul, Minn.—Hildred & Nelson.
Superior, Wis.—Superior Hardware Co.
Tulsa, Okla.—Western Rope & Cordage Co.
Valdosta, Ga. — Strickland Tillman Hardware Co.
Waco, Tex.—Herrick Hardware Co.
Wheeling, W. Va.—Chas. H. Berry Supply Co.

MAIN BELTING CO................126
Twelfth and Carpenter Sts., Philadelphia, Pa.
Branch Offices:
Atlanta, Ga.—64 S. Forsyth St.
Chicago, Ill.—J. W. Cullen, Mgr., 13-17 N. Jefferson St.
New York, N. Y.—W. C. Schreiner, Mgr., 2 Rector St.
Pittsburgh, Pa. — W. C. Schreiner, Mgr., 33 Terminal Way.
San Francisco, Cal.—Wm. M. Taylor, Mgr., 156 Second St.
Canadian Offices:
Montreal, Que., Can. — Main Belting Co. of Canada, Ltd., 10½ St. Peter St., D. E. Parker, Mgr.
Toronto, Ont.,—Foy Bldg., 32 Front St., West.

MALCOLMSON BRIQUET ENGINEERING CO. 142
Old Colony Bldg., Chicago, Ill.
Branch Offices:
New York, N. Y.—50 Church St., Room 1970.
St. Louis, Mo.—818 Security Bldg.

MANCHA STORAGE BATTERY LOCOMOTIVE CO. 494
St. Louis, Mo.

MANIERRE ENGINEERING & MACHINERY COMPANY 139
Milwaukee, Wis.
Branch Offices:
Chicago, Ill.—Link-Belt Co.
Denver, Colo.—Lindrooth, Shubart & Co.
Philadelphia, Pa.—Link-Belt Co.
Seattle, Wash.—Colliery Engineering Co.

MANUFACTURERS DISTRIBUTING CO. 190
Pittsburgh, Pa.

MARION MACHINE, FOUNDRY & SUPPLY CO...............105-196
Scottdale, Pa.
Agencies:
Birmingham, Ala.—J. F. Donohoo Co., Jefferson Co. Bank Bldg.
Bluefield, W. Va.—S. H. Meem & Co., 35 Thornton Bldg.
St. Louis, Mo.—Crockwell Mine & Mill Supply Co., Federal Reserve Bank Bldg.

MASHEK ENGINEERING CO. 143
90 West St., New York, N. Y.

List of Firms Catalogued, Branch Offices, Representatives and Agencies—Cont.

MASSILLON IRON & STEEL CO. 588-589
Massillon, O.
General Sales Office:
Chicago, Ill.—The Rookery.

MAYER BROTHERS COMPANY 704
Mankato, Minn.

MEDART PATENT PULLEY COMPANY 393
St. Louis, Mo.
Branch Offices:
Chicago, Ill.
Cincinnati, O.
Agencies:
Dallas, Tex. — Briggs-Weaver Machinery Co.
Oklahoma City, Okla.—Corken Machinery & Supply Co.

METALLURGICAL LABORATORY, THE 80
Bailey-Farrell Bldg., Pittsburgh, Pa.

MICHIGAN PIPE COMPANY, THE.592
Bay City, Mich.
Representatives:
Boston, Mass.—93 Broad St.
Chattanooga, Tenn.—319 Hamilton Natl. Bank Bldg.
Chicago, Ill.—203 S. Dearborn St.
New York, N. Y.—30 E. 42nd St.
Scranton, Pa.

MILBURN, ALEXANDER, COMPANY, THE 708
1418-28 W. Baltimore St.,
Baltimore, Md.
Agencies:
New Orleans, La.—C. T. Patterson Co.
Portland, Ore.—Railway Equipment Co.
San Francisco, Cal.—E. D. Bullard & Co.
Branch Offices:
New York, N. Y.—213 Vanderbilt Ave. Bldg., 51 E. 42nd St.
Pittsburgh, Pa.—406 Bessemer Bldg.

MILLER-OWEN ELECTRIC CO., THE 694
217-19 First Ave., Pittsburgh, Pa.

MILWAUKEE LOCOMOTIVE MFG. CO. 504
Milwaukee, Wis.
Sales Offices:
Knoxville, Tenn.—408 Burwell Bldg.
Pittsburgh. Pa. — 307-309 Westinghouse Bldg.
Agents:
San Francisco, Cal.—Westinghouse Pacific Coast Brake Company, Pacific Bldg.
Seattle, Wash. — Contractors Equipment Co.

MINE SAFETY APPLIANCES CO. 766-767-768
541 4th Ave., Pittsburgh, Pa.
Representatives:
Birmingham, Ala.
Huntington, W. Va.
Pittsburgh, Pa.
San Francisco, Cal.
Seattle, Wash.
Terre Haute, Ind.
Walsenburg, Colo.

MINERS' SUPPLY CO.............747
St. Clair, Pa.
Agencies:
Florence, Neb.—E. I. du Pont Powder Co.
Louviers, Colo.—E. I. du Pont Powder Co.
Pittsburgh, Pa. — Hercules Powder Co.
St. Louis, Mo.—E. I. du Pont Powder Co.

MINING SAFETY DEVICE COMPANY, THE 395
Bowerston, O.

MOLONEY ELECTRIC COMPANY.258
St. Louis, Mo.
Branch Offices:
Chicago, Ill.—343 S. Dearborn St.
New York, N. Y.—50 Church St.
Salt Lake City, Utah—218 Judge Bldg.
San Francisco, Cal.—315 Rialto Bldg.
Canadian Offices:
Montreal, Can.
Toronto, Can.
Winnipeg, Can.

MONARCH REFILLABLE FUSE CO., INC...................667
Buffalo, N. Y.

MOON, GEORGE C., COMPANY...406
124-126 White St., New York, N. Y.
Works: Garwood, N. J.
Branch Offices:
Cleveland, O.—872 Rockefeller Bldg.
Agencies:
San Francisco, Cal...Rolph, Mills & Co., 149 California St.
Seattle, Wash.—J. J. Matthews & Co., Terry Ave., North and Mercer St.

MORGAN-GARDNER ELECTRIC CO. 490-615
Chicago, Ill.
Agents:
Charleston, W. Va.—Cooke & Wilson Co.
Pittsburgh, Pa. — Cooke-Wilson Electric Supply Co.

MORRIS MACHINE WORKS......578
Baldwinsville, N. Y.
Branch Offices:
Boston, Mass.—Fred Goldthwait, 110 Pearl St.
Butte, Mont.—Western Mining Supply Co.
Buffalo, N. Y.—Root Neal & Co.
Charleston, S. C.—Cameron & Barkley Co.
Charlotte, N. C.—Thos. B. Whitted.
Chicago, Ill.—Henion & Hubbell, 217 N. Jefferson St.
Cleveland, O. — Strong-Carlisle-Hammond Co.
Denver, Colo.—Mine & Smelter Supply Co.
Detroit, Mich.—Chas. J. Diederich.
Houston, Tex.—H. A. Paine.
Kansas City, Mo. — English Tool & Supply Co.
Los Angeles, Cal.—Harron, Rickard & McCone.
New Orleans, La.—John H. Murphy Co.
New York, N. Y.—Hungerford Bros. & Co.
Philadelphia, Pa.—J. J. Shannon & Co., 1744 Market St.
Pittsburgh, Pa.—Harris Pump & Supply Co.
Portland, Ore. — Zimmerman, Wells-Brown Co.
St. Louis, Mo.—N. O. Nelson Mfg. Co.
St. Paul, Minn. — Robinson Cary & Sands Co.
Seattle, Wash. — Hallidie Machinery Co.
San Francisco, Cal.—Harron, Rickard & McCone.
Tampa, Fla.—Cameron & Barkley Co.
Canadian Offices:
Montreal, Que., Can.—Storey Pump & Equipment Co.
Toronto, Ont., Can.—Storey Pump & Equipment Co.

MORROW MFG. CO., THE.......108
Wellston, Ohio.

MORSE CHAIN CO.................353
Ithaca, New York
Sales Office:
Boston, Mass.—J. S. White, Mgr., 141 Milk St.
Merchants Loan & Trust Bldg.
Chicago, Ill.—Earl C. Moss, Mgr., Merchants Loan & Trust Bldg.
Cleveland, Ohio—D. I. Wheeler, Mgr., 421 Engineers Bldg.
Detroit, Mich.—F. C. Thompson, Mgr., 1003 Wodward Ave.
New York City—L. C. Biglow, Mgr., 50 Church St., Hudson Terminal Bldg.
Pittsburgh, Pa.—P. V. Stevenson, Mgr., Westinghouse Building.
San Francisco, Cal.—T. S. Wattson, Mgr., Monadnock Building.
Representatives:
Atlanta, Ga.—Earl F. Scott, M. E., 702 Candler Bldg.
Greensboro, N. C.—George W. Pritchett, 805 Ashboro Street.
Kansas City, Mo.—Morse Engineering Co., R. A. Long Building.
Minneapolis, Minn. — Strong-Scott Mfg. Co., 413 Third Street, S.
St. Louis, Mo.—Morse Engineering Co., Chemical Building.

MYERS-WHALEY CO...............631
Knoxville, Tenn.

N

NAGEL, W. G., ELECTRIC CO., THE 678
Toledo, Ohio

NATIONAL FIRE PROOFING COMPANY 159
Fulton Bldg., Pittsburgh, Pa.
Branch Offices:
Chicago. Ill.
Boston, Mass.
Philadelphia, Pa.
Washington, D. C.
Detroit, Mich.

NATIONAL PAINT & VARNISH CO., THE..........................172
Cleveland, O.

NATIONAL ROOFING CO., THE 184-185
Tonawanda, N. Y.
Agencies:
Baltimore, Md.
Baltimore, Md.—Clarke. Asphalt Roofing & Paint Co., 1048 W. Baltimore St.
Binghamton, N. Y.—Gillett Barnes, 91 State St.
Buffalo, N. Y.—Cordes, Ayrault & Co., 51 Broadway.
Chicago, Ill.—Chicago Roofing & Supply Co., 822 West 22nd St.
Cleveland, O. — National Roofing & Paint Co., 6318 Kinsman Road.
Des Moines, Ia.—National Roofing & Supply Co., 300 S. W. 9th St.
Detroit, Mich. — National Roofing & Paint Co., 395 Michigan Ave.
Louisville, Ky.—Central Paint & Roofing Co., 314 W. Main St.
Milwaukee, Wis.—Cream City Roofing & Paint Co., 219 Eighth St.
New Orleans, La. — Kracke-Flanders Co., 819 Julia St.
Niagara Falls, N. Y.—Cordes, Ayrault & Co., 1405 Main St.
Philadelphia, Pa.—H. Loeb & Son, 33rd and Master Sts.
Providence, R. I.—Narragansett Supply Co., 830 Eddy St.
St. Paul, Minn.—F. G. Leslie Co.
Syracuse, N. Y. — Onondaga Bldg. Supply Co., 569 So. Clinton St.

NATIONAL VALVE & MFG. CO..260
31st St. and Liberty Ave., Pittsburgh, Pa.
Branch Offices:
Atlanta, Ga.—E. F. Scott, 702 Candler Bldg.
Chicago, Ill.—E. J. Ward, Westminster Bldg.
Cleveland, O.—L. S. Garrett, New England Bldg.
Indianapolis, Ind. — I. C. DeHaven, State Life Bldg.
Philadelphia, Pa.—National Supply & Equip. Co., Bulletin Bldg.

NEW YORK BELTING & PACKING CO....................289
91-93 Chambers St., New York, N. Y.
Boston, Mass.—65 Pearl St.
Chicago, Ill.—124-26 W. Lake St.
Philadelphia, Pa.—821-23 Arch St.
Pittsburgh, Pa.—420 First Ave.
St. Louis, Mo.—218-220 Chestnut St.
San Francisco, Cal.—519 Mission St.
(Factories, Passaic, N. J.)

NEW YORK & NEW JERSEY LUBRICANT CO.................303
165 Broadway, New York, N. Y.
Branch Offices and Representatives:
Chicago, Ill.—M. K. Barnes, Mgr., 35 So. Dearborn St.
Charleston, W. Va.—The Kanawha Engineering Co., M. J. Carmack, Mgr., 8 Capital Street.
Huntington, W. Va.—Huntington Supply & Equipment Co., 406 Robson-Prichard Bldg.
Lexington, Ky.—H. H. Ashmore, 720 McClelland Bldg.
Butte, Mont.—J. D. Caldwell Co., 17 East Granite St.
Seattle, Wash.—Hughson & Merton, Inc., 806 East Pike St.
Portland, Oregon—Hughson & Merton, Inc., 329 Ankeny St.

NICHOLSON, W. H. & CO..........281
Wilkes-Barre, Pa.
Agents:
Chicago, Ill.—Monadnock Bldg.
Cleveland, O.—Leader News Bldg.
Pittsburgh, Pa.—Andrews-Bradshaw Co., B. F. Jones Bldg.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont.

NIXON MINING DRILL CO.......802
Chattanooga, Tenn.

NORTH CAROLINA PINE ASSOCIATION 156
Norfolk, Va.
Members:
Allen, S. C.—Trexler Lumber Co.
Badham, S. C.—Dorchester Lumber Co.
Baltimore, Md.—Surry Lumber Co., (Mill at Dendron, Va.
Barnwell, S. C.—Barnwell Lumber Co.
Boardman, N. C.—Butters Lumber Co.
Bolton, N. C.—Waccamaw Lumber Co.
Burgaw, N. C.—Garysburg Mfg. Co.
Charleston, S. C.—E. P. Burton Lumber Co.
Charleston, S. C.—North State Lumber Co.
Cheraw, S. C.—John Meikle Lumber Co.
Conway, S. C.—Conway Lumber Co.
Edenton, N. C.—Branning Mfg. Co., (Mills at Edenton, Columbia and Ahoskie, N. C.
Elizabeth City, N. C.—Dare Lumber Co.
Elizabeth City, N. C.—Foreman-Blades Lumber Co.
Franklin, Va.—Marion County Lumber Corp., (Mill at Marion, S. C.)
Franklin, Va.—Camp Mfg. Co., (Mills at Franklin, Arringdale and Butterworth, Va. and Wallace, N. C.
Georgetown, S. C.—Winyah Lumber Co.
Greeleyville, S. C.—Mallard Lumber Co.
Goldsboro, N. C.—Whiteville Lumber Co., (Mills at Whiteville, N. C.)
Greensboro, N. C.—South Atlantic Lumber Co.
Hardeeville, S. C.—Argent Lumber Co.
Hertford, N. C.—Albemarle Lumber Co.
Hertford, N. C.—Major & Loomis Co.
Ivor, Va.—Shaw Land & Timber Co.
Jacksonville, N. C.—Jacksonville Lumber Co.
Kennebec, N. C.—K. B. Johnson.
Marion, S. C.—Anderson Lumber Corp.
Morehead City, N. C.—Bogue Sound Lumber Co.
Mt. Olive, N. C.—Enterprise Lumber Co.
Mullins, S. C.—Mullins Lumber Co.
New Bern, N. C.—Broaddus & Ives Lumber Co.
New York, N. Y.—Tuxbury Lumber Co., A. C., (Mill at Charleston, S. C.)
Norfolk, Va.—Arringdale, John A., (Board of Trade Bldg.) Mill at Southern Branch, Elizabeth River.
Norfolk, Va.—Fosburgh Lumber Co., (Mill at Hollister, N. C.)
Norfolk, Va. — Greenleaf Johnson Lumber Co.
Norfolk, Va.—Richmond Cedar Works, (Mill at Dismal Swamp, Va.)
Norfolk, Va.—Roanoke R. R. & Lumber Co., (Mill at Money Point, Va.)
Norfolk, Va.—John L. Roper Lumber Co., (Mills at New Bern, Belhaven & Roper, N. C., & Gilmerton, Va.)
Norfolk, Va.—Rowland Lumber Co., (Mill at Bowden, N. C.)
Pamplico, S. C.—Dargan Wagoner Lumber Co.
Pittsburgh, Pa.—Kendall Lumber Co., Oliver Bldg., (Mill at Donora, S. C.)
Richmond, Va.—Lea Lumber Co.
Salisbury, Md.—Jackson Bros. Co., (Mills at Whaley, Va. and Salisbury, Md.)
Suffolk, Va.—Montgomery Lumber Co., (Mills at Suffolk, Va., Springhope and Middlesex, N. C.)
Suffolk, Va.—Nansemond Lumber Co.
Town Creek, N. C.—Town Creek Lumber Co.
Walterboro, S. C.—Walterboro Lumber Co.
Washington, N. C.—Eureka Lumber Co.
Williamston, N. C.—Dennis Simmons Lumber Co., (Mills at Kenly and Jamesville, N. C.)
Wilmington, N. C.—Hilton Lumber Co.

NORTHEASTERN CO., THE.......173
6 Beacon St., Boston, Mass.
Branch Offices:
New York, N. Y.—92 Wall St.
Agencies:
Chicago, Ill.—S. Reid Holland, 208 So. LaSalle St.
New Orleans, La.—H. Lynn Beach, 863 Camp Street.
Seattle, Wash.—H. D. Poitras, 1103 First Avenue.

NORTHERN EQUIPMENT COMPANY 282
Erie, Pa.
Representatives:
Atlanta, Ga.—McBurney & Jones, 829 Trust Co. of Ga. Bldg.
Birmingham Ala.—R. B. Whitacre & Co., 205 So. Robert St.
Birmingham, Ala.—J. R. Williams, P. O. Box 430.
Boston, Mass.—Schumaker-Santry Co., 141 Milk Street.
Buffalo, N. Y.—A. J. Abels Co., Inc., 728 Brisbane Bldg.
Chattanooga, Tenn.—Fuel Engineering Co., 112 East 7th St.
Chicago, Ill.—Andrews-Bradshaw Co., 540 Monadnock Block.
Cincinnati, O.—Henry P. Thompson, Mercantile Library Bldg.
Cleveland, Ohio—Andrews-Bradshaw Co., 846 Leader-News Bldg.
Denver, Colo.—Claude H. Thomas, 1st National Bank Bldg.
Detroit, Mich.—Coon-DeVisser Co., Ford Bldg.
Hazleton, Pa.—Gross Rubber & Equipment Co., 600 Markle Bank Bldg.
Houston, Tex.—Geo. S. Westerfield, 324 Chronicle Bldg.
Huntington, W. Va.—Miller Supply Co.
Indianapolis, Ind.—Mr. I. C. DeHaven, State Life Bldg.
Jacksonville, Fla.—L. E. Murphy, Esq., P. O. Box 661.
Kansas City, Mo.—Mr. F. W. Hay, 232 Lathrop Bldg.
Kansas City, Mo.—Thermal Efficiency Co., 717 Finance Bldg.
Los Angeles, Cal.—C. C. Moore & Co. Engineers, I. N. Van Nuys Bldg.
Minneapolis, Minn.—Wm. H. Hale & Co., 609-11 Fifth Ave., So.
New Orleans, La.—Mr. H. J. Malochee, 917 Hennen Bldg.
New York, N. Y.—DeVed-Kissick Co., Singer Bldg.
Philadelphia, Pa.—DeVed-Kissick Co., Commonwealth Tr. Bldg.
Pittsburgh, Pa. — Andrews-Bradshaw Co., 303-4 B. F. Jones Bldg.
San Francisco, Cal.—C. C. Moore & Co., Engineers, 1st St. Cor. of Market.
Salt Lake City, Utah—C. C. Moore & Co., Engineers, 705 Kearns Bldg.
Seattle, Wash.—C. C. Moore & Co., Engr., 618 Mutual Life Bldg.
Tucson, Ariz.—C. C. Moore & Co., Engr., Santa Rita Hotel Bldg.

NUTTALL, R. D., CO.............512
Pittsburgh, Pa.
Distributors:
Atlanta, Ga. — Geo. E. Watts, 1526 Candler Bldg.
Boston, Mass.—Chas. N. Wood Co., 14 Federal St.
Butte, Mont.—Westinghouse E. & M. Co., Lewishon Bldg.
Chicago, Ill.—Westinghouse E. & M. Co., 111 Washington St.
Dallas, Tex.—Westinghouse E. & M. Co., 418 Main St.
Denver, Colo.—Westinghouse E. & M. Co., 429 Seventeenth St.
Kansas City, Mo.—Westinghouse E. & M. Co., 1012 Baltimore Ave.
Los Angeles, Cal.—Westinghouse E. & M. Co., I. N. Van Nuys Bldg.
Philadelphia, Pa. — Electric Service Supplies Co., 17th and Cambria Sts.
Pittsburgh, Pa. — Union Electric Co., 913-925 Liberty Ave.
Portland, Ore.—Westinghouse E. & M. Co., Northwestern Bank Bldg.
St. Louis, Mo.—Westinghouse E. & M. Co., National Bank Commerce Bldg.
Salt Lake City, Utah.—Westinghouse E. & M. Co., 212 S. W. Temple St.
San Francisco, Cal.—Westinghouse E. & M. Co., 165 Second St.
Seattle, Wash.—Westinghouse E. & M. Co., Alaska Bldg.
Canadian Distributor:
Montreal, Can.—Lyman Tube & Supply Co., Toronto, Can.

O

OBERMAYER, S., CO., THE.......270
Pittsburgh, Pa.
Branch Offices:
Cincinnati, Ohio.
Cleveland, Ohio.
Denver, Colo.
Philadelphia, Pa.
St. Louis, Mo.
San Francisco, Calif.

OHIO BRASS CO., THE...........662
Mansfield, Ohio.
Branch Offices:
Chicago, Ill.—The Ohio Brass Co., 343 So. Dearborn St.
New York, N. Y.—The Ohio Brass Co., 30 Church St.
Philadelphia, Pa.—The Ohio Brass Co., 710 Witherspoon Bldg.
Sales Agents:
Birmingham, Ala.—Shook & Fletcher Supply Co.
Charleston, W. Va.—Charleston Electrical Supply Co.
Columbus, O.—Jeffrey Mfg. Co.
Columbus, O.—Columbus Mill & Mine Supply Co.
Denver, Colo. — Hendrie & Bolthoff Mfg. and Supply Co.
Fairmont, W. Va. — Fairmont Mining Machinery Co.
Los Angeles, Cal.—Holabird Electrical Co., 218 East Third St.
Pittsburgh, Pa. — Burt Gellatly, 306 Fourth Ave.
San Francisco, Cal.—Holabird Electrical Co., 525 Mission St.
Wheeling, W. Va.—Sands Electric & Mfg. Co.
Canadian Sales Agent:
Toronto, Ont., Can.—P. A. Hinds, 88 Farnham Ave.

OHIO GREASE CO., THE..........304
Loudonville, Ohio
Warehouses:
Chicago, Ill.
Cincinnati, O.
Kansas City, Mo.
Memphis, Tenn.
New Orleans, La.
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Ore.
Richmond, Va.
St. Louis, Mo.
San Francisco, Cal.
Shreveport, La.

OTTUMWA BOX CAR LOADER CO. 140-141
Ottumwa, Iowa.
Agents:
Knoxville, Tenn.—Tri-States Machinery Co., 1005 Bank & Trust Bldg.
Alabama.
Kentucky.
Tennessee.
Virginia.

OTTUMWA IRON WORKS.....384-469
Ottumwa, Iowa
Agencies:
Birmingham, Ala.—Young & Vann Supply Co.
Denver, Colo.—The Mine & Smelter Supply Co.
El Paso, Tex.—The Mine & Smelter Supply Co.
Huntington, W. Va.—Miller Supply Co.
Los Angeles, Cal.—Harron, Richard & McCone.
Salt Lake City, Utah—The Mine & Smelter Supply Co.
San Francisco, Cal.—Harron, Richard & McCone.
Spokane, Wash.—General Machinery Co.
Canadian Agencies:
Calgary, Alta.—Gorman, Clancey & Grindley.
Edmonton, Alta.—Gorman, Clancey & Grindley.
Van Couver, B. C.—Rob't. Hamilton & Co.

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PATTERSON, FRANK L., & CO...263
26 Cortlandt St., New York, N. Y.

PEASE, C. F., CO., THE...........77
221 Institute Place, Chicago, Ill.
Branch Office:
New York, N. Y.—Room 826, 30 Church St.

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PEERLESS RUBBER MFG. CO....290
31 Warren St., New York, N. Y.
(Factory, New Durham, N. J.)
Branch Offices:
Boston, Mass.—36 Oliver St.
Chicago, Ill.—130 West Lake St.
Minneapolis, Minn.—424 First Ave., North.
Philadelphia, Pa.—122 No 13th St.

PENNSYLVANIA CASTING & MACHINE WORKS...508
505 Preble Ave., N. S., Pittsburgh, Pa.
Branch Offices:
Cleveland, O.—National Car Wheel Co.
New York, N. Y.—National Car Wheel Co., 556 West 34th St.
Rochester, N. Y.—National Car Wheel Co.
Waverly, N. Y.—National Car Wheel Co.

PENNSYLVANIA CRUSHER CO...129
Stephen Girard Bldg., Philadelphia, Pa.
Branch Offices:
Pittsburgh, Pa.—Peoples Bank Bldg.
New York, N. Y.—Hudson Terminal Bldg.
Seattle, Wash.—L. C. Smith Bldg.

PERMUTIT COMPANY, THE...267
30 E. 42nd St., New York, N. Y.
Branch Sales Offices:
Buffalo, N. Y.—O. E. Honsberger, 304 Brisbane Building.
Boston, Mass. — Starkweather & Broadhurst, 53 State Street.
Chicago, Ill.—Cass L. Kennicott, 208 South La Salle St.
Cleveland, O.—Arthur Dechman, 304 Leader News Bldg.
Detroit, Mich.—John H. Heath, 1938 Dime Bank Bldg.
Jacksonville, Fla.—J. Stewart Knight, 916 Hogan Street.
Kansas City, Mo.—I. E. Leininger, 401 Lathrop Building.
Los Angeles, Cal. — F. H. Cowles, Citizens National Bank Bldg.
Minneapolis, Minn.—H. G. Taylor, 626 McKnight Building.
Philadelphia, Pa.—M. F. Corin, 311 Widener Building.
Pittsburgh, Pa.—L. S. Ferguson, 921 Union Arcade Building.
St. Louis, Mo.—Reves & Skinner Machinery Co., 2211 Oliver Street.
Hamilton, Ont., Can.—W. J. Westaway, Sun Life Bldg.

PHILADELPHIA STORAGE BATTERY CO...499
Ontario and C Sts., Philadelphia, Pa.
Branch Offices:
Atlanta, Ga.—128 West Peachtree St.
Boston, Mass.—90-92 Brookline Ave.
Chicago, Ill.—1621 S. Michigan Ave.
Cleveland, O.—613 Citizens Bldg.
Huntington, W. Va.—Hotel Huntington.
Los Angeles, Cal.—1105 W. Pico St.
New York, N. Y.—W. L. Thompson, 1789 Broadway.
Rochester, N. Y.—30 Carlton St.
Washington, D. C.—Sterrett & Fleming, 2155 Champlain Ave.

PHILLIPS MINE & MILL SUPPLY CO...118-472
Pittsburgh, Pa.
Agencies:
Huntington, W. Va. — Miller Supply Co.
Seattle, Wash.—A. F. Blair, C. & M. E.
Canadian Agency:
Lethbridge, Can.—J. B. Turney & Co.

PIONEER ELECTRIC MINE LAMP CO...752
2545-2551 North Broad Street, Philadelphia, Pa.

PITTSBURGH CARBON BRUSH CO....670
516 Federal St., Pittsburgh, Pa.

PITTSBURGH COAL WASHER CO....106-107
Fulton Bldg., Pittsburgh, Pa.

PITTSBURGH FILTER MFG. CO...268
Farmers Bank Bldg., Pittsburgh, Pa.
Branch Office:
Kansas City, Mo.—429 Rialto Bldg.

PITTSBURGH KNIFE & FORGE CO....481
709 Belmont St., N. S., Pittsburgh, Pa.
Agencies:
Denver, Colo.—Franklin Sales Co.
Huntington, W. Va.—Huntington Supply & Equipment Co.

PITTSBURGH REINFORCED BRAZING & MACH. CO...689
2525 Liberty Ave., Pittsburgh, Pa.

PLATT IRON WORKS...579
Dayton, Ohio
Atlanta, Ga.—E. C. Butner, 1019 Empire Bldg.
Baltimore, Md.—Morton McI. Dukehart, 100 West Fayette St.
Boston, Mass.—F. H. Hayes Machinery Co., 94 Pearl St.
Chicago, Ill.—John T. Shay, 1242-43 Monadnock Block.
Cincinnati, O.—W. C. Dunn, 26 Hulbert Block.
Cleveland, O.—H. W. Conrad, 550 Rockefeller Bldg.
Columbia, S. C.—Gibbes Machinery Co., Wheat & Assembly Sts.
Dallas, Texas—Briggs-Weaver Machinery Company.
Dayton, Ohio—C. M. Kelso Co., 1063-4 Reibold Bldg.
Denver, Colo.—Hendrie & Bolthoff Mfg. Co., 1621 17th St.
Detroit, Mich.—H. M. Stark, 1502 Kresge Bldg.
Indianapolis, Ind.—The Shotwell Co., 21 North Alabama St.
Jacksonville, Fla.—The Cameron & Barkley Co., 338 East Bay St.
Kansas City, Mo.—Merkle Machinery Co., 508-511 Interstate Bldg.
Los Angeles, Cal.—Sprado Engineering Co., 704 American Bank Bldg.
Memphis, Tenn.—McBee Engine & Implement Co., 24 South Front St.
Mexico City, Mex.—Babcock & Wilcox Co., Apartado, 416.
Minneapolis, Minn.—J. F. Gould, 712 Plymouth Bldg.
Montreal, Canada—Rudel-Belnap Machinery Co., 95 McGill St.
New Orleans, La.—C. T. Patterson Company.
New York, N. Y.—Room 705, 160 Broadway.
Omaha, Nebr.—Merkle Machinery Co., 1020 W. O. W. Bldg.
Philadelphia, Pa.—W. E. Herring, 1104 Commonwealth Bldg.
Pittsburgh, Pa.—Castle & Wilson, 1601 Arrott Bldg.
Portland, Oregon—Gordon & Finkbeiner, 224 Pine St.
Richmond, Va. — Hawkins-Hamilton Co., 301 American National Bank Bldg.
San Antonio, Texas—San Antonio Machine & Supply Co., 325 Center St.
San Francisco, Cal.—K. W. Eichelberger, 401 Rialto Bldg.
Salt Lake City, Utah—E. G. Dewald, 319 Kearns Bldg.
Toronto, Canada—Rudel-Belnap Machinery Co., 26 Adelaide St. West.

PNEUMELECTRIC MACHINE COMPANY, THE...385-580-623-627
Syracuse, New York

POOLE ENGINEERING & MACHINE CO...585
Woodberry, Baltimore, Md.
Branch Offices:
Boston, Mass.—Poole Engineering & Machine Co., 53 State St.
New York, N. Y.—Poole Engineering & Machine Co., 50 Church St.

PORTER, H. K., CO...501
Pittsburgh, Pa.
Branch Offices:
Minneapolis, Minn. — J. W. Copeland, Metropolitan Life Bldg.
New Orleans, La.—W. P. Luck, Godchaux Bldg.
New York, N. Y.—Wonham, Bates & Goode, Inc., 17 Battery Place.
Philadelphia, Pa. — J. M. Reed Co., Commercial Trust Bldg.
Salt Lake City, Utah. — Stimpson Equipment Co.
San Francisco, Cal. — N. D. Phelps, Sheldon Bldg.

POST-GLOVER ELECTRIC CO...679
314-6 W. Fourth St., Cincinnati, O.

POWER EFFICIENCY CORPORATION...241
102 Clinton St., Buffalo, N. Y.
Agencies:
Bridgeport, Conn.—The Wellington Co.
Cleveland, O.—Hale & Stephan Co., 500 Schofield Bldg.
New York, N. Y.—George I. Roberts & Bros., 471 Fourth Ave.
Philadelphia, Pa.—The Frick Grate Bar Co., 421 Chestnut St.
Rochester, N. Y.—The Howe & Bassett Co., 23 Stillson St.
Syracuse, N. Y.—Charles F. Wayte, University Block.
Utica, N. Y.—Charles Millar & Sons Co.

POWER SPECIALTY COMPANY..264
111 Broadway, New York, N. Y.
Branch Offices:
Boston, Mass.—50 Congress St.
Chicago, Ill.—Harris Trust Bldg.
Philadelphia, Pa.—Land Title Bldg.
Pittsburgh, Pa.—Park Bldg.
San Francisco, Calif.—Balboa Bldg.
Agencies:
Seattle, Wash.—J. D. Hull.
Canadian Agencies:
Montreal, Can.—General Supply Co. of Can. Ltd.
Ottawa, Can. General Supply Co. of Can. Ltd.
Toronto, Can.—General Supply Co. of Can. Ltd.

PRESSED STEEL CAR CO...470-471
Farmers Bank Bldg., Pittsburgh, Pa.
(Works, Hegewisch, Ill.; McKees Rocks, Pa.; N. S., Pittsburgh, Pa.)
Sales Offices:
Chicago, Ill.—Peoples Gas Bldg.
New York, N. Y.—24 Broad St.
St. Paul, Minn.—Merchants Bank Bldg.

PREST-O-LITE CO., INC., THE...709
Indianapolis, Ind.
Branch Offices:
Atlanta, Ga.—230 Peachtree Street.
Baltimore, Md.—1919 North Charles Street.
Boston, Mass.—701-05 Beacon Street.
Buffalo, N. Y.—720 Main Street.
Chicago, Ill.—2613 South Michigan Avenue.
Cincinnati, O.—118 E. Ninth Street.
Cleveland, O.—2352 Euclid Avenue.
Dallas, Tex.—1923-25 Bryan Street.
Davenport, Ia.—121-3 East Third St.
Denver, Colo.—1314-16 Acoma St.
Des Moines, Ia.—916 Locust Street.
Detroit, Mich.—1239 Woodward Ave.
Indian Orchard, Mass.
Indianapolis, Ind.—510 North Capital Avenue.
Jacksonville, Fla.—322-24 W. Adams Street.
Kansas City, Mo.—1704 Grand Ave.
Los Angeles, Cal.—15th and Hope Sts.
Memphis, Tenn.—290 Monroe Ave.
Milwaukee, Wis.—18-20 Martin St.
Minneapolis, Minn.—105 South Tenth Street.
New York, N. Y.—206-08 Amsterdam Avenue.
Omaha, Nebr.—2416 West Farnam Street.
Philadelphia, Pa.—857 North Broad Street.
Pittsburgh, Pa.—3575 Grant Blvd.
St. Louis, Mo.—2700 Locust Street.
St. Paul, Minn.—165 6th Street.
San Antonio, Tex.—625 Navaro St.
San Francisco, Cal.—1430 Van Ness Avenue.
Seattle, Wash.—921 East Pike St.
Syracuse, N. Y.—690 South Salina Street.
Canadian Branches:
Montreal Que., Canada—813 St. Catherines St. West.
Toronto, Ont., Canada—1112 C. P. R. Building.
Winnipeg, Man., Canada—579 Portage Avenue.

PROVIDENT LIFE & CASUALTY COMPANY...775
Provident Bldg., Charleston, W. Va.
Charleston, W. Va.—H. H. Huddleston, Superintendent of Agents.
Branch Offices:
Clarksburg, W. Va.—C. F. Dicken, Dist. Mgr.
Jellico, Tenn.—W. B. Siler, Special Agent for Tennessee and Southeastern Kentucky.
Jenkins, Ky.—W. B. McCall, District Agent.
Logan, W. Va.—L. F. Hale, District Manager.
Matoake, W. Va.—W. J. Elliott, Dist. Agent.
Monongahela, Pa.—E. S. McCullough, District Agent.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont.

Mt. Hope, W. Va.—J. Q. Stover, Dist. Agent.
Prestonsburg, Ky. — W. J. Ward, Agent.
Williamson, W. Va.—W. R. Duncan, District Manager.

PROX, FRANK, CO............620-621
Terre Haute, Ind.

PUNXSUTAWNEY DRILLING & CONTRACTING CO. 68
Punxsutawney, Pa.

PURITAN PAINT & OIL COMPANY 174
1310 Sheffield St., N. S. Pittsburgh, Pa.
Representative:
Uniontown, Pa.—J. Harry Gorley.

Q

QUAKER CITY RUBBER CO.....291
629 Market St., Philadelphia, Pa.
Branch Offices:
Chicago, Ill.—182 W. Lake St.
Pittsburgh, Pa.—211 Wood St.
New York, N. Y.—53 Murray St.

R

RAILWAY AND MINE SUPPLY COMPANY 791
McCormick Bldg., Chicago, Ill.

RAND, McNALLY & CO...........806
Chicago, Ill.
Branch Office:
New York, N. Y.—40-42 E. 22nd St.

RANDOLPH-MEANS CO............81
Oliver Bldg., Pittsburgh, Pa.

REINEKE-WAGNER PUMP & SUPPLY CO.....................582
416-418 First Ave., Pittsburgh, Pa.

REMALY MFG. CO................124
Tamaqua, Pa.

RENTON, WM., INC...............296
Pittsburgh, Pa.

REPUBLIC CREOSOTING COMPANY 175
Indianapolis, Ind.
Branch Offices:
Minneapolis, Minn.
Mobile, Ala.
Seattle, Wash.

RICHARDS, J. R...................69
Indiana, Pa.

RICHARDSON & CO., INC........433
Bessemer Bldg., Pittsburgh, Pa.

RIDGWAY DYNAMO & ENGINE CO. 252-253
Ridgway, Pa.
Branch Offices:
Atlanta, Ga.—Healey Bldg.
Boston, Mass.—53 State St.
Chicago, Ill.—Marquette Bldg.
Cincinnati, O.—P. O. Box 26, Burnet Woods Sta.
Cleveland, O.—Schofield Bldg.
New York, N. Y.—38 W. 32nd St.
Philadelphia, Pa.—Real Estate Trust Bldg.
Pittsburgh, Pa.—Oliver Bldg.
St. Louis, Mo.—Chemical Bldg.
Washington, D. C.—Woodward Bldg.
Wilkes-Barre, Pa.—Second Natl. Bank Bldg.
Agencies:
Denver, Colo.—Lindrooth, Shubart & Co., Boston Bldg.
Minneapolis, Minn.—L. E. Pollard Company, 505 Metropolitan Bank Bldg.
Seattle, Wash. — Hallidie Machinery Co., Occidental and King Sts.

ROBERTS AND SCHAEFER COMPANY 109
McCormick Bldg., Chicago, Ill.

ROBINS CONVEYING BELT CO...110
Park Row Bldg., New York, N. Y.
Branch Offices:
Chicago, Ill.—Old Colony Bldg.
Salt Lake City, Utah—Newhouse Bldg.
Agencies:
Birmingham, Ala.—C. B. Davis Eng. Co., Brown-Marx Bldg.
San Francisco, Cal.—The Griffin Co., Alaska Commercial Bldg.
Canadian Agency:
Toronto, Ont., Can.—Gutta Percha & Rubber Co., Ltd.

ROBINSON VENTILATING CO. 342-343
8044-45 Jenkins Arcade Bldg., Pittsburgh, Pa.

ROEBLING'S, JOHN A. SONS CO. 407-651
Trenton, N. J.
Branch Offices:
Atlanta, Ga.—69 Walton St.
Chicago, Ill.—165 West Lake St.
Cleveland, O.—701 St. Clair Ave.
Philadelphia, Pa.—223-227 Arch St.
Pittsburgh, Pa.—Sandusky and Robinson Sts.

Roebling's, John A. Sons Co., of New York.
New York, N. Y.—117-121 Liberty St.
Boston, Mass.—93-95 Pearl St.

Roebling's, John A. Sons Co., of California.
Los Angeles, Cal.—216 So. Alameda St.
Portland, Ore.—82 Fourth St.
San Francisco, Cal.—624-646 Folsom St.
Seattle, Wash.—900 First Ave.

ROYER & ZWEIBEL.............396
27-29-31 E. North St., Wilkes-Barre, Pa.
Agencies:
Cleveland, O.—The Wellman-Seaver-Morgan Co., East 70th St. and Central Ave.
Denver, Colo.—The Wellman-Seaver-Morgan Co., 612 Ideal Building.

RUMSEY PUMP COMPANY, LTD...583
Seneca Falls, N. Y.
Branch Offices and Agencies:
Boston, Mass.—Rumsey Pump Co., Ltd., 49 Federal St.
Baltimore, Md.—Lawrence Lewis, 213 Courtland St.
Charleston, S. C.—The Bailey-Lebby Co.
Charlotte, N. C.—Fraser-Purser Co.
Chicago, Ill.—Howard A. Young, 327 S. LaSalle St.
Cleveland, O.—Glenn S. Groves.
Denver, Colo.—M. J. O'Fallon Supply Co.
El Paso, Texas—Krakauer, Zork & Moye's Sucrs., Inc.
Jacksonville, Fla.—J. G. Christopher Co.
Los Angeles, Cal.—Fairbanks, Morse & Co.
New Orleans, La.—A. Baldwin & Co., Ltd.
New York, N. Y.—Rumsey Pump & Machine Co., 75 Warren St.
Omaha, Neb.—Crane Co.
Philadelphia, Pa.—Wm. M. Jackson, Bourse Bldg.
Pittsburgh, Pa. — Reineke-Wagner Pump & Supply Co.
Richmond, Va.—V. Bacigalupo.
Saginaw, Mich.—Sullivan Supply Co.
St. Louis, Mo.—Fairbanks, Morse & Co.
San Francisco, Cal.—Geo. H. Tay Co.
Seattle, Wash.—J. E. Strimple.

S

S K F BALL BEARING CO.......510
1 Wall St., New York, N. Y.

SACKETT MINE SUPPLY CO., THE 680
Columbus, Ohio.
Agent:
Welch, W. Va.—W. P. Sinclair.

SAFETY FIRST SUPPLY CO. 770-771-772
Hartje Office Bldg., Pittsburgh, Pa.

SANFORD DAY IRON WORKS....473
Knoxville, Tenn.
Branch Offices:
Birmingham, Ala. — 1308 American Trust Bldg.
New York, N. Y.—2 Rector St.
Agencies:
Bramwell, W. Va.—H. S. Brown.
Charleston, W. Va.—P. J. & C. B. Goodwin, 1 Masonic Temple Bldg.
Denver, Colo.—O. H. Davidson Equipment Co., 1633 Tremont St.
Huntington, W. Va.—W. E. Harris, First National Bank Bldg.
Minneapolis, Minn.—W. M. Ziegler, 320 Temple Court.
Salt Lake City, Utah—O. H. Davidson Equipment Co., Walker Bank Bldg.
Whites Creek, W. Va.—C. F. Millender.
Beckley, W. Va.—M. B. Smith.
Cobalt, Ont.—H. L. Usborne.
Cumberland, Md.—Chris Himmler, P. O. Box 217.

SCAIFE, WM. B., & SONS CO.....269
1st National Bank Bldg., Pittsburgh, Pa.
Branch Office:
New York, N. Y.—26 Cortlandt St.

SCALLAN SUPPLY CO., THE.....792
410 E. Pearl St., Cincinnati, O.

SCHAFFER ENGINEERING & EQUIPMENT CO., THE.........243
Tiffin, Ohio

SCRANTON ELECTRIC CONSTRUCTION CO.............628
Connell Bldg., Scranton, Pa.

SHERWIN-WILLIAMS CO., THE 176-177
601 Canal Road, N. W., Cleveland, O.
Warehouses and Offices:
Albany, N. Y.—380 Broadway.
Baltimore, Md.—8 W. Fayette St.
Binghampton, N. Y.—115 Court St.
Birmingham, Ala.—2021 N. Third Ave.
Boston, Mass.—11-13-15 Stillings St.
Buffalo, N. Y.—66-68 Erie Street.
Chicago, City Office—1101 Peoples Gas Building.
Chicago, Warehouse—2355-57 LaSalle Street.
Cincinnati, O.—Sixth and Main Sts.
Columbus, O.—16-20 E. Chestnut St.
Dallas, Texas—1605 Elm Street.
Denver, Colo.—1628 Glenarm Place.
Detroit, Mich.—475 Trombley Ave.
Fort Worth, Texas—700 Houston Ave.
Houston, Texas—622 Travis Street.
Indianapolis, Ind.—34 S. Meridian St.
Johnson City, Pa.—108 Main Street.
Kansas City, Mo.—1209 Grand Ave.
Knoxville, Tenn.—506 Gay Street.
Los Angeles, Cal.—816-22 Traction Avenue.
Minneapolis, Minn.—701-705 Third Avenue, North.
Montreal, Quebec—897 Centre Street.
Nashville, Tenn.—Fifth Avenue and Union St.
Newark, N. J.—Brown Street and Lister Avenue.
New Orleans, La.—317 Camp Street.
New York, N. Y.—116 West Thirty-second St.
Omaha, Neb.—Tenth and Dodge Sts.
Pasadena, Cal.—113-115 East Colorado Street.
Peoria, Ill.—318 South Adams St.
Philadelphia, Pa.—Delaware Ave. and Chestnut St.
Pittsburgh, Pa.—927 Liberty Avenue.
San Antonio, Tex.—101 East Commerce St.
San Francisco, Cal.—454-466 Second Street.
Savannah, Ga.—745 Wheaton Street.
Seattle, Wash.—512 First Ave., South.
Spokane, Wash.—Railroad Ave. and Wall Street.
St. Louis, Mo.—Second and Clinton Streets.
Toronto, Ont.—86 York Street.
Vancouver, B. C.—827 Powell Street.
Waco, Texas—720 Austin Avenue.
Winnipeg, Man.—Vincent and Whyte Avenues.

SIMMONS, JOHN, CO.............761
34 Thirty-fifth St., Brooklyn, N. Y.
Branch Offices:
Denver, Colo.—304 Colorado Bldg.
San Francisco, Cal.—268 Market St.
Springfield, Ill.—1028 E. Madison St.
Canadian Office:
Toronto, Ont.—100 Wellington St., W.

SIMS COMPANY, THE............265
Erie, Pa.
Branch Offices and Agencies:
Atlanta, Ga.—Earl F. Scott, Candler Bldg.
Birmingham, Ala. — Moore-Handley Hardware Co.
Chicago, Ill. — B. W. Thurtell, 22 Quincy St.
Denver, Colo.—Mine & Smelter Supply Co.
Huntington, W. Va.—Huntington Supply & Equip. Co.
New York, N. Y.—W. B. Connor, Inc., 90 West St.
Philadelphia, Pa.—E. D. Mendell, 5 South 18th.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont.

Pittsburgh, Pa. — Guy L. Andrews, 1732 Buena Vista St.
St. Louis, Mo.—Henry M. Fife, 1111 Holland Bldg.

SMITH, L. C., & BROS., TYPEWRITER CO.....................782
Syracuse, N. Y.
Branch Offices in all Principle Towns and Cities.

SOMERS, FITLER & TODD CO....705
327 Water St., Pittsburgh, Pa.

SOUTH SIDE FOUNDRY & MACHINE WORKS..............386
Charleston, W. Va.

SOUTHERN COUPON COMPANY..807
Birmingham, Ala.

SPRAY ENGINEERING COMPANY 266
Boston, Mass.
Branch Offices and Agents:
Atlanta, Ga.—Earl F. Scott, 702 Candler Bldg.
Birmingham, Ala.—McClary-Jemison Machy. Co.
Charlotte, N. C.—J. S. Cothran, 1006 Commercial Bank Bldg.
Chicago, Ill.—Spray Engineering Co., 712 Peoples Gas Bldg.
Cincinnati, O.—Henry P. Thompson, Mercantile Library Bldg.
Cleveland, O.—Glenn S. Groves, 959 Leader-News Bldg.
Dallas, Texas—Smith & Whitney, Southwestern Life Bldg.
Denver, Colo.—Stearns-Roger Mfg. Co., 1718 California St.
Houston, Texas—Tennant-Lovegrove Co., Union National Bank Bldg.
Indianapolis, Ind.—I. C. DeHaven, State Life Bldg.
Kansas City, Mo.—Merkle Machinery Co., 508 Interstate Bldg.
Los Angeles, Cal.—C. C. Moore & Co., Engineers, I. N. VanNays Bldg.
Minneapolis, Minn.—Wm. H. Hale & Co., 609-611 5th Ave. S.
New Orleans, La.—A. M. Lockett & Co., 533 Baronne St.
New York City, N. Y.—B. C. Donham & Co., 52 Broadway.
Philadelphia, Pa.—H. F. Sanville, 1326 Chestnut St.
Pittsburgh, Pa.—H. A. Rapelye, Oliver Bldg.
St. Louis, Mo.—Baumes-McDevitt Machinery Co., 1984 Railway Exchange Bldg.
San Francisco, Cal.—C. C. Moore & Co., Engineers, Sheldon Bldg., 1st St. cor. Market St.
Salt Lake City, Utah—C. C. Moore & Co., Engineers, 705 Kearns Bldg.
Seattle, Wash.—C. C. Moore & Co., Engineers, Mutual Life Bldg.
Tucson, Ariz.—C. C. Moore & Co., Engineers, Santa Rita Hotel Bldg.
Toledo, O.—Power Equipment Co., 712 Second National Bank Bldg.
Canadian Offices:
Montreal, Que.—Rudel-Balnap Machinery Co., 95 McGill St.
Toronto, Ont. — Rudel-Balnap Machinery Co., 26 Adelaide St., West.

STACKPOLE CARBON CO.........671
St. Marys, Pa.

STANDARD ROLLER BEARING COMPANY 511
Philadelphia, Pa.
Branch Offices:
Chicago, Ill.—1742 Monadnock Block.
Detroit, Mich.—1852 Penobscot Bldg.
Indianapolis, Ind.—822 Hume Mansur Bldg.
Service Sales Branches:
Boston, Mass.—1632 Massachusetts Ave.
Chicago, Ill.—2206 Michigan Ave.

STANDARD SANITARY MFG. CO., THE.......................793
(Standard Division) 439 Water St.
Pittsburgh, Pa.
Branch Offices:
Altoona, Pa.
Columbus, O.
Wheeling, W. Va.
Youngstown, O.

STANDARD SCALE & SUPPLY CO. 136
1631 Liberty Ave., Pittsburgh, Pa.
Branch Offices:
Baltimore, Md.—409-411 N. Gay St.
Chicago, Ill.—169 N. May St.
Cincinnati, O.—212 Walnut St.
Cleveland, O.—Columbus Road.
New York, N. Y.—145 Chambers St.
Philadelphia, Pa.—523 Arch St.

STANDARD UNDERGROUND CABLE CO.......................652
Westinghouse Bldg., Pittsburgh, Pa.
Sales Offices:
Atlanta, Ga.—Candler Bldg.
Boston, Mass.—Delta Bldg.
Chicago, Ill.—Conway Bldg.
Detroit, Mich.—Whitney Bldg.
Los Angeles, Cal.—Hibernian Bldg.
Minneapolis, Minn.—Plymouth Bldg.
New York, N. Y.—Hudson Terminal Bldg.
Philadelphia, Pa.—North American Bldg.
St. Louis, Mo.—Security Bldg.
Salt Lake City, Utah—Newhouse Bldg.
San Francisco, Cal.—First National Bank Bldg.
Seattle, Wash.—Central Bldg.
Washington, D. C.—Wilkins Bldg.
Standard Underground Cable Co. of Canada, Ltd., Hamilton, Ont.
Sales Offices:
Hamilton, Ont.—Sherman Ave.
Montreal, Que.—McGill Bldg.
Toronto, Ont.—201 C. P. R. Bldg.

STANDARD WOOD PIPE CO.....593
Williamsport, Pa.

STAR MFG. CO., THE.........476-581
New Lexington, O.

STARK ROLLING MILL CO., THE..163
Canton, Ohio

STEDMAN'S FOUNDRY & MACHINE WORKS..............132
Aurora, Ind.

STEPHENS-ADAMSON MFG. CO. 111
Aurora, Ill.
Branch Offices:
Boston, Mass.—Colwell & McMullin, Mgrs., 79 Milk St.
Chicago, Ill.—First Natl. Bank Bldg.
Detroit, Mich.—824 Dime Bank Bldg.
Huntington, W. Va.—First Natl. Bank Bldg.
New York, N. Y.—50 Church St.
Pittsburgh, Pa.—H. W. Oliver Bldg.
St. Louis, Mo.—Federal Reserve Bank Bldg.
Salt Lake City, Utah.—J. W. Gates, Mgr., 503 Dooly Block.
Canadian Office:
Toronto, Ont.—E. J. Bansfield, Agent, 310 Stair Bldg.

STERLING EQUIPMENT & SUPPLY COMPANY.............271
245 Race St., Philadelphia, Pa.

STERLING VARNISH CO., THE...672
Pittsburgh, Pa.
Branch Offices:
Chicago, Ill.—615 Monadnock Block.
New York, N. Y.—50 Church St.
Agents:
Birmingham, Ala.—Robertson Sales Co.
Boston, Mass.—Frank Ridlon Co.
Buffalo, N. Y.—McCarthy Bros. & Ford.
Chicago, Ill.—Electric Service Supplies Co.
Denver, Colo.—The Hendrie & Bolthoff Mfg. and Supply Co.
Los Angeles, Cal. — The Graham-Reynolds Elec. Co.
New York, N. Y.—Curtis & Carhart, Inc.
Philadelphia, Pa.—Electric Service Supplies Co.
San Francisco, Cal.—Holabird Electrical Co.
Seattle, Wash.—Pacific States Electric Co.
St. Louis, Mo.—Wesco Supply Co.
Canadian Agents:
Montreal, Que.—Dawson & Co., Ltd.
Winnipeg, Man.—Dawson & Co., Ltd.

STINE, J. C., CO., THE...........344
Tyrone, Pa.

STONEHOUSE STEEL SIGN COMPANY, THE................774
17th and Lawrence Sts., Denver, Colo.
Agencies:
Birmingham, Ala.—Fossick Co.
Boston, Mass.—Waterman & Leavitt, 107 Eustis St.
Butte, Mont.—Anaconda Copper Mining Co.
Chicago, Ill.—Safety Service & Supplies Co., 10125 Ave. M.
El Paco, Tex.—Mine & Smelter Supply Co.
Pittsburgh, Pa.—Mine Safety Appliances Co., 541 Fourth Ave.
San Francisco, Cal.—E. D. Bullard, 221 Hansford Block.
Seattle, Wash.—H. H. Sanderson, L. C. Smith Bldg.
Canadian Agencies:
Sherbroke, Que., Can.—Jenckes Machinery Co.
Vancouver, B. C., Can.—Charles S. Meek & Co., Ltd.

STREETER-AMET WEIGHING & RECORDING CO..............137
4101-05 Ravenswood Ave., Chicago, Ill.

SULLIVAN MACHINERY CO....70-616
122 So. Michigan Ave., Chicago, Ill.
Branch Offices:
Boston, Mass.—185 Devonshire St.
Claremont, N. H.
Denver, Colo.—837 Equitable Bldg.
El Paso, Tex.—511 Mills Bldg.
Huntington, W. Va.—841 Court St.
Knoxville, Tenn.—Houston Bldg.
New York, N. Y.—30 Church St.
Pittsburgh, Pa.—Farmers Bank Bldg.
St. Louis, Mo.—Railway Exchange.
Salt Lake City, Utah.—Kearns Bldg.
San Francisco, Cal.—582 Market St.
Spokane, Wash.—Hutton Bldg.
Canadian Offices:
Toronto, Ont., Can.—37 Colborne St.
Vancouver, B. C., Can.—Granville St. Bridge.

SWABY MANUFACTURING COMPANY 584
2010 Marshall Blvd., Chicago, Ill.
Sales Agencies:
Chattanooga, Tenn.—1106 Market St.
Denver, Colo.—1621-39 Seventeenth Street.
Joplin, Mo.—209 E. Fourth St.
Pittsburgh, Pa.—320-22 Second Ave.

SWEET'S STEEL COMPANY...424-425
Williamsport, Pa.
Branch Offices:
New York, N. Y.—2 Rector St.
Philadelphia, Pa.—Land Title Bldg.
Agencies:
Cleveland, O. — H. D. Cushman Co., 952 Rockefeller Bldg.
San Francisco, Cal.—Pelton & Pelton, 454 Montgomery St.
Canadian Agency:
Montreal, Can. — Rubinovich & Haskell, 346 Notre Dame St., W.

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TAMAQUA MFG. CO...............119
Tamaqua, Pa.

TEMPLETON, KENLY & CO., LTD. 779
1020 South Central Ave., Chicago, Ill.
Agencies:
Alexandria, La. — Brown - Roberts Hardware Co.
Atlanta, Ga.—Fulton Supply Company.
Atlanta, Ga.—Seeger-Walraven Co.
Bangor, Me.—Rice & Miller.
Bay City, Mich.—Alert Pipe & Supply Co.
Beaumont, Tex.—E. L. Wilson Hardware Co.
Birmingham, Ala. — Moore-Handley Hardware Co.
Chicago, Ill.—Geo. B. Carpenter & Co.
Cincinnati, O.—Queen City Supply Co.
Cleveland, O.—Geo. Worthington & Co.
Dallas, Tex.—Moroney Hardware Co.
Davenport, Ia.—Sickels & Preston Co.
Denver, Colo.—Mine & Smelter Supply Co.
Detroit, Mich.—Buhl Sons Company.
Elmira, N. Y.—Barker, Rose & Clinton Co.
El Paso, Tex.—Krakauer, Zork & Moye's Sucs., Inc.

List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont-

Grand Rapids, Mich.—Sherwood Hall Co., Ltd.
Greensboro, N. C.—Odell Hardware Co.
Hartford, Conn.—Hartford Contractors Supply Co.
Houston, Tex.—Peden Iron & Steel Company.
Huntington, W. Va.—Banks Supply Company.
Indianapolis, Ind.—Van Camp Hardware Co.
Indianapolis, Ind.—Vonnegut Hardware Company.
Jacksonville, Fla.—J. G. Christopher Co.
Joplin, Mo.—Joplin Supply Co.
Kansas City, Mo.—Gustin Bacon Mfg. Co.
Louisville, Ky.—Todd Donigan Iron Co.
Lynchburg, Va.—Barker, Jennings Hardware Co.
Macon, Ga.—Corbin Supply Company.
Mobile, Ala.—Turner Supply Company.
Nashville, Tenn.—Gray & Dudley Hdwe. Co.
New Orleans, La.—C. T. Patterson Co.
New Orleans, La.—Oliver H. Van Horn, Inc.
New York, N. Y.—H. A. Rogers & Co.
Norfolk, Va.—Southern Supply Company.
Pittsburgh, Pa.—Somers, Fitler & Todd Co.
Providence, R. I.—Congdon & Carpenter.
Richmond, Va.—Smith Courtney Co.
Saginaw, Mich.—Alert Pipe & Supply Co.
St. Louis, Mo.—Simmons Hdwe. Co.
St. Paul, Minn.—Rank & Goodell.
Salt Lake City, Utah—Mine & Smelter Supply Co.
San Antonio, Tex.—Peden Iron & Steel Co.
San Francisco, Cal.—Dunham, Carrigan & Hayden Co.
Shreveport, La.—W. K. Henderson Iron Wks. & Supply Co.
Sioux Falls, S. D.—Dakota Iron Stores Co.
Springfield, Mass.—Chas. C. Lewis Co.
Toronto, Ont., Can.—A. C. Lewis Co.
Troy, N. Y.—J. M. Warren & Co.
Tulsa, Okla.—Frick Reid Supply Co.
Wausau, Wis.—Radcliffe Machinery Co.
Wilkes-Barre, Pa.—Eastern Pennsylvania Supply Co.
Wilmington, N. C.—Hyman Supply Co.
Worcester, Mass. — Brierly-Lombard Co.
Youngstown, O.—Stambaugh Thompson Co.

TEXAS COMPANY, THE.......**410-411**
Texas Company Bldg., Houston, Tex.
Branch Offices:
Atlanta, Ga.—161 W. Georgia Ave.
Birmingham, Ala.—American Bank & Trust Bldg.
Boston, Mass.—201 Devonshire St.
Chicago, Ill.—McCormick Bldg.
Dallas, Tex.
Denver, Colo.—First Natl. Bank Bldg.
El Paso, Tex.
New Orleans, La.—Baronne and Girod Sts.
New York, N. Y.—Whitehall Bldg., 17 Battery Place.
Norfolk, Va.—Royster Bldg.
Philadelphia, Pa.—Widener Bldg.

THERMOID RUBBER CO...........**398**
Trenton, N. J.
Branch Offices:
Boston, Mass.
Chicago, Ill.
Detroit, Mich.
Indianapolis, Ind.
Los Angeles, Cal.
New York, N. Y.
Philadelphia, Pa.
Pittsburgh, Pa.
San Francisco, Cal.
St. Louis, Mo.

THEW AUTOMATIC SHOVEL CO., THE........................**629**
Lorain, O.
Representatives:
Altoona, Pa.—Standard Supply & Equipment Co.
Kansas City, Mo.—V. L. Phillips.
Miami, Fla.—L. D. Llewellyn, Box 626.
New York, N. Y.—Allied Constr. Mchy. Corp., 120 Broadway.
New York, N. Y.—H. A. McLaughlin, Room 303, 30 Church St.
Oakland, Cal.—Graves-Spears Road Machinery Co.
Philadelphia, Pa.—Standard Supply & Equipment Co.
Portland, Ore.—Clyde Equipment Co.
Salt Lake City, Utah—Ambler, Ott & Riter, Kearns Bldg.
Seattle, Wash.—Clyde Equipment Co.
Canadian Representatives:
Winnipeg, Man., Can.—N. J. Dinnen & Co.

TOLEDO PIPE THREADING MACHINE CO., THE............**711**
1445 Summit St., Toledo, O.
Branch Office:
New York, N. Y.—Room 369 Hudson Terminal, 50 Church St., Clarence A. Popp.

TOOL STEEL GEAR & PINION CO., THE **513**
Elmwood Place, Cincinnati, O.
Agencies:
Chicago, Ill.—National Ry. Appliance Co., McCormick Bldg.
Denver, Colo.—F. C. Webb, Equitable Bldg.
Huntington, W. Va. — Huntington Supply & Equipment Co.
New York, N. Y.—National Railway Appliance Co., 50 E. 42nd St.
Pittsburgh, Pa.—J. P. Biggert, Oliver Bldg.
Salt Lake City, Utah—Ambler, Ott & Riter, Kearns Bldg.

TRACY, BERTRAND P. **617**
3201 Penn Ave., Pittsburgh, Pa.

TRANTER MFG. CO...............**795**
105 Water St., Pittsburgh, Pa.

TRUSSED CONCRETE STEEL COMPANY **160-161**
Detroit, Mich.
Branch Offices:
Atlanta, Ga.—C. C. Whitaker, 600 Forsyth Bldg.
Baltimore, Md.—E. L. Benedict, Munsey Bldg.
Boston, Mass.—L. A. Estes, 146 Summer St.
Buffalo, N. Y.—G. S. Gildersleeve, 644 Prudential Bldg.
Cincinnati, O.—A. Levinson, 617 Provident Bank Bldg.
Chicago, Ill.—C. H. Gagen, 1506 Garland Bldg.
Cleveland, O.—Cott & Mohrman, 1118 Citizens Bldg.
Columbus, O.—E. A. Silagi, 1000 Col. Savings & Trust Bldg.
Dallas, Tex.—Walter C. Conger, 738 Wilson Bldg.
Dayton, O.—G. H. Condit, 604 Commercial Bldg.
Des Moines, Ia.—A. Stockelbach, 411 Hubbell Bldg.
Denver, Colo.—G. W. Phillips, 510 Colorado Bldg.
Detroit, Mich.—M. Goldenberg, Trussed Concrete Bldg.
El Paso, Tex.—W. A. E. Woods, Neff-Stiles Bldg.
Indianapolis, Ind.—C. B. Mayer, 1411 Fletcher Sav. & Trust Bldg.
Kansas City, Mo.—Louis Baum, 611 Bryant Bldg.
Louisville, Ky.—S. Turnheim, 628 Paul Jones Bldg.
Los Angeles, Cal.—E. C. Noyes, 1520 Shearer St.
Milwaukee, Wis.—I. S. Leland, 415 M. & M. Bank Bldg.
Minneapolis, Minn.—E. C. McMillan, 603 Metropolitan Bank Bldg.
New Orleans, La.—Lee Christy, 314 Hennen Bldg.
New York City, N. Y.—Herman Fougner, 110 W 40th St.
Norfolk, Va.—A. P. Long, 416 Dickson Bldg.
Oklahoma City, Okla.—Reinhart & Donovan.
Omaha, Neb.—H. E. Gaden, 1111 W. O. W. Bldg.
Philadelphia, Pa.—B. J. Sigmund, 810 Commonwealth Bldg.
Pittsburgh, Pa.—C. D. Loveland, 2541 Oliver Bldg.
Portland, Ore.—J. A. Currey, 194 N. 13th St.
Roswell, N. M.—W. A. Wilson, 11-12 Citizens Bank Bldg.
St. Paul, Minn.—J. J. Crotty, 817 Commerce Bldg.
St. Louis, Mo.—E. S. Clymonts, 1210 Syndicate Trust Bldg.
Salt Lake City, Utah—Frank M. Allen, 423-4 McIntyre Bldg.
San Antonio, Tex.—P. N. Geren, 534 Bedell Bldg.
San Francisco, Cal.—Holloway Expanded Metal Co.
Seattle, Wash.—G. A. Muessel, 448 Central Bldg.
Spokane, Wash.—R. W. Adams, 1120 Old Nat'l Bldg.
Syracuse, N. Y.—John Fielding, 444 Gurney Bldg.
Toledo, O.—B. E. Bowlus, 518-19 Spitzer Bldg.
Washington, D. C.—Hewitt Wells, 314 Woodward Bldg.
Canadian Branch:
Walkerville, Ont., Can.—Trussed Concrete Steel Co. of Can., Ltd.

TURNER, C. A., INCORPORATED..**795**
Pittsburgh, Pa.

TURNER, LAURIN H., & CO.....**355**
812 Merchants Loan & Trust Bldg., Chicago, Ill.

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UNION CARBIDE SALES CO......**762**
42nd St. Bldg., **New York, N. Y.**
Chicago, Ill.—Peoples Gas Bldg.
San Francisco, Cal.—Kohl Bldg.
Branch Offices:
Alabama:
Birmingham—1916 Morris Ave.
Mobile—16 So. Commerce St.
Montgomery—114 N. Perry St.
Arizona:
Phoenix—42 S. Central Ave.
California:
Eureka—109 Second St.
Fresno—932 H St.
Los Angeles—639 Gibbon St.
Sacramento—1523-31 Front St.
San Diego—326-336 Fifth St.
San Francisco—Kohl Bldg.
Colorado:
Denver—19th and Wazee Sts.
Victor—Third and Diamond Sts.
Connecticut
Hartford—877 Main St.
District of Columbia
Washington—Maryland Ave. and 9th St., S. W.
Florida:
Jacksonville—515 West Bay St.
Tampa—418 Tampa St.
Georgia:
Atlanta—Cor. Haynes and Rhodes Sts., P. O. Box 1594.
Savannah—Ogeechee Canal, South of Bay St., P. O. Box 78.
Illinois:
Chicago—Peoples Gas Bldg., Michigan Blvd.
Decatur—133 W. William St.
East St. Louis—600 Walnut Ave.
Marion—315 S. Granite St., Box 747.
Monmouth—601 S. First St.
Peoria—721-731 So. Washington St.
Quincy—222 S. Eighth St.
Streator—702 East Elm St.
Indiana:
Evansville—1601 Illinois St.
Indianapolis—110-112 S. Alabama St.
Terre Haute—921 Wabash Ave.
Iowa
Des Moines—117-119 Fifth St.
Dubuque—8th and Washington Sts.
Ottumwa—207-9-11 S. Washington St.
Sioux City—P. O. Box 398.
Kansas:
Pittsburg—109 W. Third St.
Salina—154 S. Fifth St.
Wichita—721 Beacon Bldg.
Kentucky:
Louisville—126 E. Main St.
Middlesboro—
Louisiana:
New Orleans—819-21 Julia St.
Maine:
Portland—202 Commercial St.
Maryland:
Baltimore—19 E. Lombard St.
Cumberland—1 N. Liberty St.
Salisbury—Mill St. opp. Fulton Station.
Massachusetts:
Cambridge—241 Albany St.
Springfield—Napier St.
Michigan:
Detroit—475 Woodward Ave.
Grand Rapids—500 Shawmut Ave. N. W.
Hancock—First Natl. Bank Bldg.
Ironwood—
Iron Mountain—215 E. "A" St.

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List of Firms Catalogued, Branch Offices, Representatives and Agencies---Cont.

Ishpeming—
Jackson—172 South Water St.
Saginaw—1830-40 N. Michigan Ave.
Stambaugh—
Sault Ste. Marie.

Minnesota:
Minneapolis—334 N. First St.
Virginia—413 Chestnut St.

Mississippi:
Vicksburg—1312 Washington St.

Missouri:
Kansas City—1316-1318 W. 8th St.
St. Joseph—920 S. 6th St., Sta. "A."
St. Louis—(See East St. Louis, Ill).

Nebraska:
Omaha—1007-9-11 Jones St.

New Jersey:
Camden—657 S. Second St.
Jersey City—554-56 Henderson St.

New York:
Albany—Montgomery and Colonie Sts.
Binghamton—21 Jarvis St.
Geneva—Exchange St. and Railroad Place.
Jamaica—11 New York Ave.
Kingston—O'Neil St., near Broadway.
New York City—42nd St. Bldg.
Niagara Falls.
Poughkeepsie—Smith St. and N. Y., N. H. & H. R. R. Tracks.
Roscoe.
Utica—135 Hotel St.
Watertown—438 Court St.
Whitehall—22-23 Main St.

North Carolina:
Wilmington—13-15-17 N. Front St.

North Dakota:
Fargo—17-19 Broadway.

Ohio:
Cincinnati—63-65 Plum St.
Cleveland—601 The Citizens' Bldg.
Columbus—330 Dublin Ave.
Dayton—812-828 E. First St.
Lima—338 East High St.
Toledo—414 S. Erie St.
Zanesville—Main and Second Sts.

Oklahoma:
Oklahoma City—27-29 E. Grand Ave.

Oregon:
Portland—15 Hoyt St.

Pennsylvania:
Beaver—934 Third Ave.
DuBois—Weber Ave. and Franklin St.
Erie—1426 Chestnut St.
Harrisburg—627 Walnut St.
Johnstown—Messenger St. and B. & O. R. R.
Pittsburgh—32nd St. and Penna. R. R.
Pottsville — Railroad and Sanderson Sts.
Scranton—4 Cliff St.
Shamokin—
Williamsport—Canal and Court Sts.

Rhode Island:
Providence—Allen's Ave., P. O. Box 419.

South Carolina:
Charleston—153 Church St.

Tennessee:
Chattanooga—823 James Ave.
Knoxville—426 West Depot Ave.
Memphis—671 South Main St.
Nashville—105-107-109 Broadway.

Texas:
Dallas—802-810 Cadiz St.
El Paso—900 E. Overland St.
Houston—Baker and Cedar Sts., Box 745.
San Antonio—Cor. Leal and N. Salado Sts.
Waco—633 So. Seventh St.

Utah:
Salt Lake City—118 W. Second South St.

Vermont:
Burlington—Cor. College and Champlain Sts.

Virginia:
Lynchburg—1324 Commerce St.
Norfolk—513 Front St.
Richmond—18th and Cary Sts.

West Virginia:
Bluefield—195 Roanoke St.
Charleston—Broad St. and K. & M. R. R.
Fairmont—"A" St.
Huntington—820 Third Ave.

Washington:
Seattle—1103 First Ave.
Spokane—646 Peyton Bldg.

Wisconsin:
La Crosse—Front and King Sts.
Madison—309 East Wilson St.
Milwaukee—120-134 Jefferson St.

UNION ELECTRIC COMPANY.....681
933-935 Liberty Ave., Pittsburgh, Pa.

UNION IRON WORKS, THE......231
Erie, Pa.

Branch Offices and Agencies:
Boston, Mass. — Starkweather & Broadhurst, 53 State St.
Buffalo, N. Y.—550 Ellicott Square Bldg.
Chicago, Ill.—330 Old Colony Bldg.
Cleveland, O.—Cleveland Office, 550 Rockefeller Bldg.
Kansas City, Mo.—Merkle Machinery Co.
New York, N. Y.—Edwin H. Ludeman, 165 Broadway.
Philadelphia, Pa.—Dravo-Doyle Co., Commercial Trust Bldg.
Pittsburgh, Pa. — Dravo-Doyle Co., Diamond Bank Bldg.
Scranton, Pa.—Scranton Supply & Machinery Co.
Syracuse, N. Y.—Chas. F. Wayte, 524 University Bldg.
Washington, D. C.—L. C. Holmes, Ouray Bldg.

Toledo-Detroit Agency:
Toledo, O.—W. Hawley & Co., 950 Nichols Bldg.

UNITED STATES GRAPHITE COMPANY 305
Saginaw, Mich.

Branch Offices:
Atlanta, Ga.—Candler Bldg.
Chicago, Ill.—630 Railway Exchange.
Denver, Colo.—Gas & Electric Bldg.
New York, N. Y.—30 Church St.
Philadelphia, Pa.—Land Title Bldg.
Pittsburgh, Pa.—Fulton Bldg.
St. Louis, Mo.—Railway Exchange Bldg.
San Francisco, Cal.—Phelan Bldg.

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Cumberland, Md.

UNITED STATES CAST IRON PIPE & FOUNDRY CO.......588-589
Burlington, N. J.

General Sales Office:
Philadelphia, Pa.—1421 Chestnut St.

Branch Sales Offices:
New York, N. Y.—71 Broadway.
Chicago, Ill.—122 So. Michigan Ave.
Birmingham, Ala.—American Trust Bldg.
Kansas City, Mo.—R. A. Long Bldg.
Pittsburgh, Pa.—Oliver Bldg.
St. Louis, Mo.—Security Bldg.
San Francisco, Cal.—Monadnock Bldg.
Seattle, Wash.—Coleman Bldg., First Ave.

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41 Park Row, New York, N. Y.

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Branch Offices:
New York, N. Y. — Room 707, 30 Church St.

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14 E. Jackson Blvd., Chicago, Ill.

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Wilkes-Barre, Pa.

Branch Offices:
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Chicago, Ill.—913 McCormick Bldg.
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New Orleans, La.—Frank Davis, 210 Hennen Bldg.
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Chattanooga, Tenn.

Branch Offices:
Birmingham, Ala.—L. G. Haller, 715 Brown-Marx Bldg.
Dallas, Tex.—M. G. Lipscomb, 1308 Busch Bldg.
Knoxville, Tenn.—Tennessee Mill & Mine Supply Co., 516 State St.
Memphis, Tenn.—McBee Engine & Implement Co.
New Orleans, La.—Friend & Webre, 908 Hibernia Bank Bldg.
New York, N. Y.—A. C. Weigel, 11 Broadway, Room 515.
Norfolk, Va.—Empire Foundry & Machine Co.
San Francisco, Cal.—California Hydraulic Eng. & Sup. Co., 70 Fremont St.

WARWOOD TOOL COMPANY.....803
Wheeling, W. Va.

WATERBURY COMPANY 408
63 Park Row, New York, N. Y.

Agent:
Dallas, Tex.—A. T. Powell & Co., 911 Southwestern Life Bldg.

Branch Offices:
Chicago, Ill.—W. R. Peete, Mgr., 1315 West Congress St.
New Orleans, La.—Wm. Fitzpatrick, 1018 Maison Blanche Bldg.
San Francisco, Cal.—Frank J. Sime, 151 Main St.

WARREN FOUNDRY & MACHINE CO. 588-589
11 Broadway, New York, N. Y.

WATT MINING CAR WHEEL CO., THE 474-475
Barnesville, Ohio.

Agencies:
Denver, Colo.—Lindrooth, Shubart & Co.
San Francisco, Cal. — N. D. Phelps, Sheldon Bldg.
...**(Agents in all foreign countries.)**...

WAYNE OIL TANK AND PUMP CO. 306
Fort Wayne, Ind.

Branch Offices:
Atlanta, Ga.—266 W. North Ave.
Boston, Mass.—Publicity Bldg.
Chicago, Ill.—1400 S. Michigan Ave.
Denver, Colo.—734 Gas and Electric Bldg.
Detroit, Mich.—874 Woodward Ave.
Duluth, Minn.—1403 Alworth Bldg.
Memphis, Tenn.—245 Monroe Ave.
New York, N. Y.—1790 Broadway.
Philadelphia, Pa.—304½ N. Broad St.
Pittsburgh, Pa.—401 Union Arcade.
San Francisco, Cal.—4th and Harrison Sts.
Wichita, Kan.—Beacon Bldg.

WEBB, S. C., COMPANY.........397
Box 48, Wilkes-Barre, Pa.

WEBSTER MFG. COMPANY, THE.112
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Branch Offices:
Chicago, Ill.—McCormick Bldg.
New York, N. Y.—90 West St.

Representatives:
Atlanta, Ga.—Fulton Supply Co., 86 Marietta St.
Birmingham, Ala.—G. R. Mueller, Brown-Marx Bldg.
Buffalo, N. Y.—Hancock Engineering Corp., 21 Terrace.
Chattanooga, Tenn.—R. R. Nixon, Hamilton National.
Columbus, O.—P. W. Holstein, 235 16th Ave.
Denver, Colo.—C. L. Dean, 1718 California Ave.
Detroit, Mich. — Palmer-Bee Co., Grand Boulevard.
Douglas, Ariz.—L. W. Mendenhall, P. O. Box 531.
Knoxville, Tenn.—Webster & Co., Holston Bank Bldg.
Milwaukee, Wis.—William Clasmann, Wells Bldg.

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Philadelphia, Pa.—W. V. Duke, 520 Arch St.
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San Francisco, Cal.—L. E. Sperry, 629 Howard St.
Seattle, Wash.—Brinkeley Supply Co., 524 First Ave., South.
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WEIR FROG COMPANY..........439
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Southern Sales Agent:
Washington, D. C.—R. H. Pilson, 809 Munsey Bldg.

Branch Offices:
Cincinnati, O.—C. E. Hogan.
Louisville, Ky.—T. C. Coleman, American Natl. Bank Bldg.
San Francisco, Cal.—Allen L. Wetmore, 614-5 Balboa Bldg.

WELLMAN-SEAVER-MORGAN CO. 388
East 70th St. and Central Ave.,
Cleveland, Ohio.

Branch Offices:
Denver, Colo.—612 Ideal Bldg.
New York, N. Y.—50 Church St.

WEST VIRGINIA RAIL CO., THE 427
Huntington, W. Va.

WESTERN ELECTRIC COMPANY, INC. 682-683
195 Broadway, New York, N. Y.

Branch Offices:
Atlanta, Ga.—230 Lee St.
Baltimore, Md.—425 East Oliver St.
Birmingham, Ala.—1621 First Ave.
Boston, Mass.—383-385 Summer St.
Buffalo, N. Y.—709-711 Main St.
Charlotte, N. C.—238 West 1st St.
Chicago, Ill.—500 S. Clinton St.
Cincinnati, O.—129 Government Sq.
Cleveland, O.—413-415 Huron Road.
Dallas, Tex.—Pacific Ave. and Ervay St.
Denver, Colo.—1425-1429 Curtis St.
Detroit, Mich.—Kirby Ave. and Dequindre St.
Houston, Tex.—100-104 Jackson St.
Indianapolis, Ind.—121-123 S. Pennsylvania St.
Kansas City, Mo.—608-610 Wyandotte St.
Los Angeles, Cal.—301 East 8th St.
Milwaukee, Wis.—458 Milwaukee St.
Minneapolis, Minn.—114-120 Third St., N.
New Haven, Conn.—135 Wood St.
New Orleans, La.—309 Magazine St.
New York, N. Y.—463 West St.
Newark, N. J.—64 Park Place.
Oakland, Cal.—1900 Telegraph Ave.
Oklahoma City, Okla.—1 East 6th St.
Omaha, Neb.—802 Farnam St.
Philadelphia, Pa.—11th and York Sts.
Pittsburgh, Pa. — 910 River Ave., Northside.
Portland, Ore.—14 Union Ave.
Richmond, Va.—6th and Cary Sts.
St. Louis, Mo.—814 Spruce St.
St. Paul, Minn.—63 East 6th St.
Salt Lake City, Utah—41-43 Third South St.
San Francisco, Cal.—680 Folsom St.
Savannah, Ga.—210-214 Bay St., W.
Seattle, Wash.—84 Marion St.

WESTINGHOUSE ELECTRIC & MFG. CO. 134-250-251-392-491-587-663
East Pittsburgh, Pa.

Sales Offices:
Atlanta, Ga. — Candler Bldg., 127 Peachtree St.
Baltimore, Md.—Westinghouse Bldg., 121 E. Baltimore St.
Birmingham, Ala.—Brown-Marx Bldg., Bldg., First Ave. and 20th St.
Bluefield, W. Va.—Law & Commerce
Boston, Mass.—Rice Bldg., 10 High St.
Buffalo, N. Y.—Ellicott Square Bldg., Ellicott Square.
Butte, Mont. — Montana Electric Co. Bldg., 50-52 East Broadway.
Charleston, W. Va. — Union Trust Bldg.
Charlotte, N. C. — Rooms 409-10-11, Commercial Bank Bldg., Cor. Tryon and Fourth Sts.
Chattanooga, Tenn.—Hamilton National Bank Bldg.
Chicago, Ill.—Conway Bldg., 111 W. Washington St.
Cincinnati, O.—Traction Bldg., Fifth and Walnut Sts.
Cleveland, O. — Swetland Bldg., 1010 Euclid Ave.
Columbus, O. — Interurban Terminal Bldg., Third and Rich Sts.
Dallas, Tex.—Cotton Exchange Bldg., Akard and Wood Sts.
Dayton, O.—Reibold Bldg., Main St.
Denver, Colo.—Gas & Electric Bldg., 910 Fifteenth St.
Des Moines, Ia.—416 Seventh St.
Detroit, Mich. — Dime Savings Bank Bldg., Fort and Griswold Sts.
Duluth, Minn.—Provident Bldg., 332-334 West Superior.
El Paso, Tex. — Mills Bldg., Oregon and Mills Sts.
Westinghouse Electric & Mfg. Co. of Texas.
Indianapolis, Ind.—Traction Terminal Bldg., Illinois and Market Sts.
Joplin, Mo.—BaSom Bldg., 418 Joplin St.
Kansas City, Mo.—Orear-Leslie Bldg., 1012 Baltimore Ave.
Louisville, Ky. — Paul Jones Bldg., 312 Fourth Ave.
Los Angeles, Cal.—I. N. Van Nuys Bldg., Seventh and Spring Sts.
Memphis, Tenn.—Exchange Bldg., 6 N. Second St.
Milwaukee, Wis.—First Natl. Bank Bldg, 425 E. Water St.
Minneapolis, Minn.—Met. Life Insurance Bldg., 119-131 Third St.
New Orleans, La. — Maison Blanche Bldg., 921 Canal St.
New York, N. Y. — City Investing Bldg., 165 Broadway.
Philadelphia, Pa. — Widener Bldg., 325-329 Chestnut St.
Phoenix, Ariz.—16 S. Center St.
Pittsburgh, Pa. — Union Bank Bldg., 306 Wood St.
Portland, Ore. — Northwestern Bank Bldg., Broadway and Morrison St.
Rochester, N. Y.—Chamber of Commerce Bldg., 119 E. Main St.
St. Louis, Mo.—300 N. Broadway.
Salt Lake City, Utah.—Walker Bank Bldg., Second, South and Main Sts.
San Francisco, Cal.—First National Bank Bldg., 1 Montgomery St.
Seattle, Wash.—Alaska Bldg., Second and Cherry Sts.
Syracuse, N. Y. — University Bldg., 120 Vanderbilt Square.
Toledo, O.—Ohio Bldg., Madison Ave. and Superior St.
Washington, D. C.—Hibbs Bldg., 723 Fifteenth St., N. W.
Wilkes-Barre, Pa.—Miners Bank Bldg.

WESTINGHOUSE LAMP CO.......755
165 Broadway, New York, N. Y.

Factories—Bloomfield, N. J.; Milwaukee, Wis.; New York, N. Y.; Trenton, N. J.

District Sales Offices:
Atlanta, Ga.—Candler Bldg.
Baltimore, Md.—121 East Baltimore St.
Boston, Mass.—10 High St.
Buffalo, N. Y.—Ellicott Square.
Chicago, Ill.—Conway Bldg.
Cincinnati, O.—Traction Bldg.
Cleveland, O.—Swetland Bldg.
Columbus, O.—Interurban Bldg.
Dallas, Tex.—Cotton Exchange Bldg.
Denver, Colo.—Gas & Electric Bldg.
Detroit, Mich.—Dime Savings Bank Bldg.
Kansas City, Mo.—1012 Baltimore Ave.
Los Angeles, Cal.—815 Van Nuys Bldg.
Milwaukee, Wis.—3100 Center St.
Minneapolis, Minn. — Metropolitan Life Bldg.
New Orleans, La.—Maison-Blanche Bldg.
New York, N. Y.—City Investing Bldg.
New York Export—City Investing Bldg.
Philadelphia, Pa.—Widener Bldg.
Pittsburgh, Pa.—Union Natl. Bank Bldg.
St. Louis, Mo.—Boatmen's Bank Bldg.
San Francisco, Cal.—First National Bank Bldg.
Seattle, Wash.—Alaska Bldg.
Syracuse, N. Y.—University Bldg.

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Branch Offices:
Altanta, Ga.—Candler Bldg.
Boston, Mass.—Exchange Bldg.
Chicago, Ill. — Railway Exchange Bldg.
Columbus, O.—Columbus Savings & Trust Bldg.
Denver, Colo.—Tramway Bldg.
Houston, Tex.—4802 Main St.
Los Angeles, Cal.—Pacific Electric Bldg.
New York, N. Y.—City Investing Bldg.
Pittsburgh, Pa.—Westinghouse Bldg.
St. Louis, Mo.—Boatmen's Bank Bldg.
St. Paul, Minn.—Endicott Bldg.
Salt Lake City, Utah—McIntyre Bldg.
San Francisco, Cal.—Pacific Bldg.
Seattle, Wash.—Securities Bldg.
Topeka, Kan.—New England Bldg.

WHITCOMB, GEO. D., COMPANY 495-505
Rochelle, Ill.

Branch Offices:
Charleston, W. Va.—Kanawha Natl. Bank Bldg.
Pittsburgh, Pa.—1106 House Bldg.

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Saginaw, Mich.

Branch Offices:
Boston, Mass.—The Wickes Boiler Co., 201 Devonshire St.
Chicago, Ill.—The Wickes Boiler Co., 76 West Monroe St.
Detroit, Mich. — The Wickes Boiler Co., 1116 Penobscot Bldg.
New York, N. Y.—The Wickes Boiler Co., 1417 West St. Bldg.

WILLIAMS IMPROVED STRETCHER CO. 773
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WILLIAMS PATENT CRUSHER & PULVERIZER CO.........130-131
Old Colony Bldg., Chicago, Ill.

Main Office:
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Branch Offices:
Cleveland, O.—327 Engineers Bldg.
Detroit, Mich.—Jas. H. Phinney & Co., Penobscot Bldg.
New York, N. Y.—59 Cortlandt St.
Philadelphia, Pa.—484 The Bourse.
Pittsburgh, Pa.—2223 Farmers Bank Bldg.
Richmond, Va.—Shields M. Bishop, 905 4th Ave. H. P.
San Francisco, Cal.—67 Second St.

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12th to 13th St. on 6th Ave.,
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WINTERER, HERMAN L.........696
943-53 N. Front St., Philadelphia, Pa.

Agent:
Hazleton, Pa.—Fred M. Blethen, 704 Markle Bank Bldg.

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Agents:
Chicago, Ill. — C. W. Brooks, 1619 Monadnock Bldg.
Detroit, Mich. — Walter T. Curtis, 1362 Penobscot Bldg.
Kansas City, Mo. — W. L. Six, 510 Finance Bldg.

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Branch Offices:
Knoxville, Tenn.—Holston Bank Bldg.
Pittsburgh, Pa.—Fulton Bldg.

WRIGHT WIRE COMPANY.......409
Worcester, Mass.

Branch Offices:
Boston, Mass.—256 Franklin St.
Chicago, Ill.—33 West Austin Ave.
Emlenton, Pa.—Geo. W. Klingler.
New York, N. Y.—256 Broadway.
Philadelphia, Pa.—410 Commerce St.
San Francisco, Cal. — 111 Townsend St.
Tulsa, Okla.—Bruce C. Thorp, 312 Mays Bldg.

WYOMING SHOVEL WORKS, THE 804
Wyoming, Pa.

Branch Offices and Agencies:
Atlanta, Ga.—P. O. Box 203.
Atlanta, Ga.—C. H. Broward.
Boston, Mass.—118 Pearl St.
Boston, Mass.—R. B. McKim Co.
Chicago, Ill.—Peoples Gas Bldg.
Chicago, Ill.—G. E. Geer.
Cleveland, O.—Osborn Mfg. Co.
Denver, Colo.—1615 Blake St.
Denver, Colo.—James C. Dolan.
Minneapolis, Minn.—Temple Court.
Minneapolis, Minn.—Wm. H. Ziegler.
New York, N. Y.—165 Broadway.
New York, N. Y.—N. E. Brooks.
Philadelphia, Pa.—Commercial Trust Bldg.
Philadelphia, Pa.—Read-Rittenhouse Co.
Phoenix, Ariz.—431 S. 3rd Ave.
Phoeniz, Ariz.—J. V. Williams.
Pittsburgh, Pa.—108 West Park Way, N. S.
Pittsburgh, Pa.—Beckwith Machinery Co.
Richmond, Va.—Mutual Bldg.
Richmond, Va.—Jos. F. Leonard.
St. Louis, Mo.—113 N. 2nd St.
St. Louis, Mo.—Southern Railway Supply & Equipment Co.
Salt Lake City, Utah—
Salt Lake City, Utah—Galigher Machinery Co.
San Francisco, Cal.—268 Market St.
San Francisco, Cal.—C. L. Lewis.
Tacoma, Wash.—Fidelity Bldg.
Tacoma, Wash.—Wm. B. Knoble.

Canadian Offices:
Montreal, Que., Can.—20 St. Nicholas St.
Montreal, Que., Can.—R. E. Cleaton Co.

Y

YOUNGSTOWN STEEL CAR CO., THE 477
Youngstown, Ohio.

Branch Offices and Agencies:
New York, N. Y.—J. D. Miller, Taylor Bldg.
Philadelphia, Pa.—C. G. A. Schmidt, Jr., 639 Land Title Bldg.
Salt Lake City, Utah. — Stimpson Equipment Co., Felt Bldg.
San Francisco, Cal.—N. D. Phelps, 505 Sheldon Bldg.
Seattle, Wash.—Raun Engineering & Equipment Co., 936 Henry Bldg.

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

INDEX OF PRODUCTS

Please bear in mind that this is NOT a Buyers' Guide, but AN INDEX OF PRODUCTS of machinery, equipment, apparatus and supplies mentioned, described, or illustrated in the catalog pages; for instance, if you are seeking information regarding gears for locomotives, look under the general heading of **Gears**, and get the page numbers of the different manufacturers of that commodity, and read their catalog page over carefully for the information desired. With but few exceptions, we have listed the commodity under the main noun, as example; when looking up Safety Lamps, look under the heading **Lamps, Safety**, etc., or Mine Car Wheels, ferer to **Wheels, Mine Car**, etc.

We have endeavored to make this Products Index as simple as possible, but in all cases it is expedient to refer to the catalog pages where you can get the addresses, branch offices and trade names of the different firms supplying the commodity you want.

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Fulton Tool Co., The............798
Hardsocg Mfg. Co. 800-801
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Howells Mining Drill Co.........626
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ELECTRIC ROCK DRILLS.
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Atlas Powder Co............732-733
Austin Powder Co..............734
Du Pont, E. I., de Nemours & Co. 736-737-738-739
Grasselli Powder Co.............735
Hercules Powder Co.....740-741-742
King Powder Co................745
McAbee, G. R., Powder & Oil Co..743

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Aetna Explosive Co., Inc....730-731
Atlas Powder Co............732-733
Austin Powder Co..............734
Du Pont, E. I., de Nemours & Co. 736-737-738-739
Grasselli Powder Co.............735
Hercules Powder Co.....740-741-742
Illinois Powder Mfg. Co..........744
King Powder Co................745
McAbee, G. R., Powder & Oil Co..743

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Frick & Lindsay Co.........788-789
Harker Mfg. Co................759
Mine Safety Appliances Co. 766-767-768
Safety First Supply Co...770-771-772
Scallan Supply Co., The.........792

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FACINGS—Foundry.
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Colonial Supply Co......785-786-787
Doubleday-Hill Electric Co.......684
Sackett Mine Supply Co., The...680
Post-Glover Electric Co., The....679

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Jeffrey Mfg. Co................100
Kanawha Mfg. Co...............103
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Stephens-Adamson Mfg. Co......111
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Mine Safety Appliances Co.766-767-768
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Mine Safety Appliances Co. 766-767-768
Safety First Supply Co..770-771-772
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Somers, Fitler & Todd Co.......705

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Gem Mfg. Co..................295

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American Mine Door Co., The.654-655
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Electric Railway Equipment Co..660
Flood City Mfg. Co.........658-659
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Aetna Explosives Co., Inc....730-731
Du Pont, E. I., de Nemours & Co. 736-737-738-739
Ensign-Bickford Co., The........746
Grasselli Powder Co.............735
Hercules Powder Co.....740-741-742
McAbee, G. R., Powder & Oil Co..743
Illinois Powder Mfg. Co.........744
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Burson Supply Co...............783
Colonial Supply Co......785-786-787
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McCullough, W. T., Electric Co..677
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Aetna Explosives Co., Inc....730-731
Atlas Powder Co............732-733
Du Pont, E. I., de Nemours & Co. 736-737-738-739
Grasselli Powder Co............735
Hercules Powder Co.....740-741-742

GAS DETECTORS.

Mine Safety Appliances Co. 766-767-768

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Davis-Bournonville Co..........706
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GLASSES—Gauge (Metallic).

Durabla Mfg. Co...............286

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Durabla Mfg. Co...............286

GLOVES—Asbestos Fiber and Rubber

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GOGGLES.

Safety First Supply Co...770-771-772
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Everhart Brass Works, The......394
McCullough, W. T., Electric Co..677
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GOVERNORS—Hoist.

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Dixon, Jos. Crucible Co..........300
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Cataract Refining Co............301
Dixon, Jos., Crucible Co.........300
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Somers, Fitler & Todd Co.......705
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Electric Service Supplies Co..656-657
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Ilg Electric Ventilating Co......347
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Buettner & Shelburne Machine Co., Inc. 618-619
Prox, Frank, Co............620-621
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HANGERS—Pipe.
(See also Mine Supplies.)
Crane Co. 276-277
National Valve & Mfg. Co.......260

HANGERS—Pulley and Shaft.
(See also Mine Supplies.)
Dodge Sales & Engineering Co. 292-293
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Tranter Mfg. Co................795
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(See also Mine Supplies.)
Burson Supply Co............783
Colonial Supply Co......785-786-787
Frick & Lindsay Co..........788-789
Iron City Electric Co...........675

HARPS—Trolley.
(See also Electric Supplies.)
Electrical Material Co...........673
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HARNESS
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HARNESS—Leather.
(See also Mine Supplies.)
Frick & Lindsay Co..........788-789
Manufacturers Distributing Co...190
James, Edward F., Sales Co......780
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Fairmont Mining Machinery Co.92-95
Broderick & Bascom Rope Co.....401
Heyl & Patterson, Inc............97
Holmes, Robt., & Bros., Inc.......379
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Lidgerwood Mfg. Co.........380-381
Litchfield Foundry & Machine Co.383
Vulcan Iron Works..............387
Wellman-Seaver-Morgan Co., The.388

HAULS—Car.
(See Car Hauls.)

HEADER LINES—Welded.
National Valve & Mfg. Co.......260

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Crane Co....................276-277
National Valve & Mfg. Co.......260
Standard Sanitary Mfg. Co., The..793

HEADLIGHTS—Incandescent and Arc.
(See also Electric Supplies.)
Electric Service Supplies Co.....506
Electrical Material Co...........673
Gee Electric Co.................674
General Electric Co.............507
Iron City Electric Co............675
Kester Electric Co..............676
Railway & Mine Supply Co......791
Tracy, Bertrand P...............617
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HEATERS—Hot Water Service.
Patterson, Frank L., & Co.......263
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Colonial Supply Co......785-786-787
Frick & Lindsay Co.........788-789
Hockensmith Wheel & Mine Car Co., The..................464-465
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Macomber & Whyte Rope Co....480
Phillips Mine & Mill Supply Co...472
Pittsburgh Knife & Forge Co.....481
Railway & Mine Supply Co......791

HOISTS—Air.
Carlin, John H., Machine Co.....691
Flory, S., Mfg. Co...........376-377
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Allen & Garcia Co...............90
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Beckwith Machinery Co.........690
Cherry Tree Machine Co.........371
Connellsville Mfg. & Mine Suppply Co. 372
Crawford & McCrimmon Co.....374
Diamond Machine Co............375
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Pneumelectric Machine Co.......385
Sackett Mine Supply Co., The....680
Tranter Mfg. Co.................795
South Side Foundry & Machine Works 386
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Vulcan Iron Works..............387
Wellman-Seaver-Morgan Co., The.388

HOISTS—Gasoline.
Beckwith Machinery Co..........690

HOISTS—Hand.
Beckwith Machinery Co..........690
Connellsville Mfg. & Mine Supply Co. 372
Flory, S., Mfg. Co...........376-377

HOISTS—Room and Gathering.
Beckwith Machinery Co.........690
Diamond Machine Co............375
Cherry Tree Machine Co.........371
Connellsville Mfg. & Mine Supply Co. 372
Dravo-Doyle Co..................382
Flory S., Mfg. Co............376-377
Lidgerwood Mfg. Co.........380-381
Marion Machine, Foundry & Mine Supply Co., The..............105
Ottumwa Iron Works............384
Pneumelectric Machine Co.......385
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HOISTS—Steam.
Allen & Garcia Co..............90
Allis-Chalmers Mfg. Co..........370
Beckwith Machinery Co..........690
Carlin, John H., Machine Co.....691
Crawford & McCrimmon Co.....374
Connellsville Mfg. & Mine Supply Co. 372
Dravo-Doyle Co..................382
Flory, S., Mfg. Co. 376-377
Holmes, Robt., & Bros., Inc.......379
Houston, Stanwood & Gamble Co.229
Krehbiel Co.......................99
Lidgerwood Mfg. Co.........380-381
Litchfield Foundry & Machine Co.383
Marion Machine, Foundry & Mine Supply Co. 105
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Carlin, John H., Machine Co.....691
Contractors'. Machinery & Supply Co. 428
Eagle Pipe Supply Co., Inc.......594
Foster, L. B., Co.................429
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McCoy-Brandt Machinery Co.....695
Miller-Owen Electric Co., Inc....694
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Drake, A. W., Drilling Co........66

HOLLOW TILE.
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Burson Supply Co..............783
Colonial Supply Co......785-786-787
Cancos Mfg. Co.................285
Childs, H. L., & Co.............784
Frick & Lindsay Co.........788-789
Goodrich, B. F., Co., The........288
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Quaker City Rubber Co.........291
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Vogt, Henry, Machine Co........232

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Diamond Machine Co...........375
Gustafson Mfg. Co..............462
Stine, J. C., Co., The...........344
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American Steel & Wire Co.......648
D & W Fuse Co.................649
Electrical Materials Co..........673
Hazard Mfg. Co.................650
Iron City Electric Co............675
Johns, H. W., -Manville Co.......182
McCullough, W. T., Electric Co..677
Standard Underground Cable Co.652
Union Electric Co...............681
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Iron City Electric Co............675
McCullough, W. T., Electric Co..677
Post-Glover Electric Co., The.....679
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United States Graphite Co., The..305
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Carey, Philip, Co., The..........180
D & W Fuse Co.................649
Doubleday-Hill Electric Co.......684
Electrical Material Co...........673
Johns, H. W., -Manville Co......182
McCullough, W. T., Electric Co..677
Post-Glover Electric Co., The....679
Tracy, Bertrand P.............617
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Gee Electric Co..........674
Electrical Material Co..........673
Electric Service Supplies Co..656-657
Iron City Electric Co..........675
McCullough, W. T., Electric Co..677
Ohio Brass Co., The..........662
Sackett Mine Supply Co., The....680
Union Electric Co..........681
Western Electric Co..........682-683

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Provident Life & Casualty Co...775

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Berger, C. L., & Sons..........73
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Elliott, B. K., Co..........75
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(See also Mine Supplies.)
American Sheet & Tin Plate Co..162

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(See also Mine Supplies.)
Carnegie Steel Co..........157

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(See also Mine and Electric Supplies.)
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Hardsocg Mfg. Co..........801
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Scallan Supply Co., The..........792
Templeton, Kenly & Co., Ltd....779
Union Electric Co..........681
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Duff Mfg. Co., The..........777
Joyce-Cridland Co., The..........778
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JACKS—Locomotive and Mining Machine.
Duff Mfg. Co., The..........777
Joyce-Cridland Co., The..........778
Templeton, Kenly & Co., Ltd....779

JACKS—Mine Car.
Duff Mfg. Co., The..........777
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(See also Mine Supplies.)
National Valve & Mfg. Co..........260

JOINTS—Swivel Expansion.
(See also Mine Supplies.)
Crane Co..........276-277

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JOINTS—Pressed Steel.
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Tamaqua Mfg. Co..........119

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LADDER SHOES—Safety.
Safety First Supply Co..770-771-772

LAMP ACCESSORIES—Safety.
(See Lamps—Miners' Safety.)

LAMP BULBS—For Safety Lamps.
(See also Electric Supplies.)
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Concordia Safety Lamp Co., Inc. 750-751
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Pioneer Electric Mine Lamp Co..752
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LAMP GUARDS.
(See also Electric Supplies.)
Electric Service Supplies Co..656-657
McCullough, W. T., Electric Co..677

LAMPS—Arc and Incandescent.
Edison Lamp Works 754
Electrical Material Co. 673
Doubleday-Hill Electric Co.......684
Iron City Electric Co. 675
McCullough, W. T., Electric Co....677
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Harker Mfg. Co. 759
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Justrite Mfg. Co. 760
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Milburn, Alexander, Co., The.....708
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Simmons, John, Co. 761

LAMPS—Carbide Accessories.
Grier Bros. Co., The 758
Harker Mfg. Co. 759
Hughes Brothers 756
Milburn, Alexander, Co., The 708
Justrite Mfg. Co. 760
Simmons, John, Co. 761

LAMPS—Electric, Hand.
Concordia Safety Lamp Co., Inc. 750-751
Pioneer Electric Mine Lamp Co...752

LAMPS—Electric Safety, Cap (Mfg.).
Concordia Safety Lamp Co., Inc. 750-751
Edison Storage Battery Co......749
General Electric Co. 661
Pioneer Electric Mine Lamp Co...752
Witherbee Igniter Co. 753

LAMPS—Electric Trip.
Concordia Safety Lamp Co., Inc. 750-751
Edison Storage Battery Co......749
Mine Safety Appliance Co. 766-767-768
Pioneer Electric Mine Lamp Co..752
Witherbee Igniter Co. 753

LAMPS—Flare (Portable).
Milburn, Alexander, Co., The.....708
Prest-O-Lite Co., Inc., The.......709

LAMPS—Mazda.
(See Electric Suppplies.)

LAMPS—Miners' Safety.
Hughes Brothers 756
Mine Safety Appliance Co. 766-767-768

LAMPS—Oil.
(See aslo Mine Supplies.)
Leetonia Tool Co., The..........799

LAMP TESTING BOXES.
Mine Safety Appliances Co. 766-767-768

LANTERNS.
(See also Mine Supplies.)
Burson Supply Co. 783
Colonial Supply Co.......785-786-787
Scallan Supply Co., The..........792

LANTERNS—Electric Safety (Hand).
Pioneer Electric Mine Lamp Co...752
Safety First Supply Co..770-771-772

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Connellsville Mfg. & Mine Supply Co. 372-373
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Marion Machine, Foundry & Supply Co., The 196
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McCoy-Brandt Machinery Co.....695
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LEADING WIRE REELS.
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LEADITE.
Leadite Company, The 595

LEATHER—All Kinds.
Burson Supply Co. 783
Colonial Supply Co......785-786-787
Frick & Lindsay Co..........788-789
James, Edward F., Sales Co......780
Manufacturers Distributing Co....190
Railway & Mine Supply Co......791

LEGGINGS—Asbestos Fibre.
Safety First Supply Co...770-771-772

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Berger, C. L., & Sons 73
Buff & Buff Mfg. Co............ 74
Elliott, B. K., Co................ 75
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(See Electric Supplies.)

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American Mine Door Co., The.654-655
Electrical Material Co...........673
Electric Railway Equipment Co...660
Electric Service Supplies Co..656-657
Doubleday-Hill Electric Co.......684
Duquesne Electric & Mfg. Co.....692
Flood City Mfg. Co.........658-659
Gee Electric Co. 674
General Electric Co. 661
Iron City Electric Co...........675
Johns, H. W.-Manville Co........182
Kester Electric Co. 676
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McCullough, W. T., Electric Co....677
Nagel, W. G., Electric Co., The...678
Ohio Brass Co., The............662
Post-Glover Electric Co., The....679
Railway & Mine Supply Co.......791
Sackett Mine Supply Co., The....680
Tracy, Bertrand P...............617
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Virginian Electric & Machine Works 687
Western Electric Co. 682-683
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Sterling Varnish Co., The.......672

LOADERS—Boom.
South Side Foundry & Machine Works 386

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Foster, L. B., Co. 429
Frank, M. K. 430
Front Construction Co. 693
Green, L. A. 431
Kester Electric Co. 676
Lazarus, M. E., Co., The 432
McCoy-Brandt Machinery Co. 695
Miller-Owen Electric Co., Inc. 694
Nagel, W. G., Electric Co., The 678
Post-Glover Electric Co. 679
Railway & Mine Supply Co. 791
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Carlin, John H., Machine Co. 691
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Miller-Owen Electric Co., Inc. 694
Nagel, W. G., Electric Co., The 678
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Mine Safety Appliances Co. 766-767-768
Safety First Supply Co..770-771-772

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Schaffer Engineering & Equipment Co. 243

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PORTABLE ELECTRIC TOOLS.

Somers, Fitler & Todd Co........705

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Prest-O-Lite Co., Inc., The.......709

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Mine Safety Appliances Co. 766-767-768
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POWDER FLASKS.

Safety First Supply Co..770-771-772

POWER HACK SAWS.

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American Well Works, The..552-553
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Colonial Supply Co......785-786-787
Dodge Sales & Engineering Co.292-293
Duquesne Electric & Mfg. Co.....692
Frick & Lindsay Co..........788-789
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Medart Patent Pulley Co.........393
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Scallan Supply Co., The..........792
Stephens-Adamson Mfg. Co......111
Tamaqua Mfg. Co...............119
Tranter Mfg. Co.................795
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Cameron, A. S., Steam Pump Works 556-557
Carlin, John H., Machine Co.....691
Connellsville Mfg. & Mine Supply Co. 558
De Laval Steam Turbine Co......559
Deming Co., The............560-567
Du Bois Iron Works............569
Epping-Carpenter Pump Co......571
Fairmont Mining Mchy. Co..572-573
Goulds Mfg. Co............574-575
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Kerr Turbine Co................254
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American Well Works, The..552-553
Deming Co., The.............560-567
Goulds Mfg. Co.............574-575
Harris Pump & Supply Co......576
Luitwieler Pumping Engine Co..577
Morris Machine Works..........578
Rumsey Pump Co., Ltd...........583

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Aldrich Pump Co., The.548-549-550-551
American Steam Pump Co.......555
Deming Co., The............560-567
Dravo-Doyle Co.................568
Epping-Carpenter Pump Co......571
Fairmont Mining Machinery Co. 572-573
Goulds Mfg. Co..............574-575
Harris Pump & Supply Co......576
Luitwieler Pumping Engine Co..577
Platt Iron Works...............579
Pneumelectric Machine Co., The..580
Reineke-Wagner Pump & Supply Co. 582
Stine, J. C., Co., The............344

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Allis-Chalmers Mfg. Co..........554
American Well Works, The..552-553
Beckwith Machinery Co.........690
Cameron, A. S., Steam Pump Works 556-557
Carlin, John H., Machine Co......691
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Elmore, G. H...................570
Epping-Carpenter Pump Co......571
Goulds Mfg. Co..............574-575
Harris Pump & Supply Co.......576
Ingersoll-Rand Co...............256
Kerr Turbine Co................254
Morris Machine Works..........578
Platt Iron Works...............579
Reineke-Wagner Pump & Supply Co. 582
Rumsey Pump Co., Ltd..........583
Swaby Mfg. Co.................584
Tranter Mfg. Co................795

PUMPS—Piston Type.

Aldrich Pump Co., The.548-549-550-551
American Steam Pump Co.......555
Cameron, A. S., Steam Pump Works 556-557
Connellsville Mfg. & Mine Supply Co. 558
Crawford & McCrimmon Co.....374
Deming Co., The...........560-567
Epping-Carpenter Pump Co......571
Fairmont Mining Machinery Co. 572-573
Goulds Mfg. Co............574-575
Harris Pump & Supply Co......576
Platt Iron Works...............579
Reineke-Wagner Pump & Supply Co. 582
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American Steam Pump Co.......555
Aldrich Pump Co............548-551
American Well Works, The..552-553
Cameron, A. S., Steam Pump Works 556-557
Connellsville Mfg. & Mine Supply Co. 558
Deming Co., The............560-567
Epping-Carpenter Pump Co......571
Fairmont Mining Machinery Co. 572-573
Goulds Mfg. Co.............574-575
Harris Pump & Supply Co......576
Liutwieler Pumping Engine Co...577
Platt Iron Works...............579
Reineke-Wagner Pump & Supply Co. 582
Rumsey Pump Co., Ltd..........583

PUMPS—Power.
Aldrich Pump Co., The 548-549-550-551
Allis-Chalmers Mfg. Co..........554
American Steam Pump Co........555
Cameron, A. S., Steam Pump Works 556-557
Carlin, John H., Machine Co.....691
Connellsville Mfg. & Mine Supply Co. 558
Crawford & McCrimmon Co.....374
Deming Co., The...........560-567
Du Bois Iron Works............569
Epping-Carpenter Pump Co......571
Fairmont Mining Machinery Co. 572-573
Goulds Mfg. Co.............574-575
Harris Pump & Supply Co.......576
Luitwieler Pumping Engine Co..577
Morris Machine Works..........578
Platt Iron Works...............579
Reineke-Wagner Pump & Supply Co. 582
Rumsey Pump Co., Ltd..........583
Stine, J. C., Co., The...........344
Tranter Mfg. Co................795

PUMPS—Hand.
Deming Co., The............560-567
Goulds Mfg. Co..............574-575
Harris Pump & Supply Co.......576
Reineke-Wagner Pump & Supply Co. 582
Rumsey Pump Co., Ltd..........583
Wayne Oil Tank & Pump Co....306

PUMPS—Sinking.
American Well Works.......552-553
Deming Co., The............560-567
Gould Mfg. Co..............574-575
Luitwieler Pumping Engine Co...577
Morris Machine Works..........578

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Aldrich Pump Co., The 548-549-550-551
American Steam Pump Co.......555
Cameron, A. S., Steam Pump Works 556-557
Carlin, John H., Machine Co.....691
Connellsville Mfg. & Mine Supply Co. 558
Deming Co., The............560-567
Dubois Iron Works.............569
Epping-Carpenter Pump Co......571
Goulds Mfg. Co.............574-575
Harris Pump & Supply Co......576
Luitwieler Pumping Engine Co...577
Platt Iron Works...............579
Reineke-Wagner Pump & Supply Co. 582
Rumsey Pump Co., Ltd..........583
Tranter Mfg. Co................795

PUMPS—Vacuum.
Aldrich Pump Co....548-549-550-551
Goulds Mfg. Co.............574-575
Ingersoll-Rand Co..............256

PUMPS—Acid-Resisting.
Allis-Chalmers Mfg. Co..........554
Connellsville Mfg. & Mine Supply Co. 558
Crawford & McCrimmon Co.....374
Elmore, G. H...................570
Morris Machine Works..........578
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Beckwith Machinery Co..........690
Burson Supply Co..............783
Carlin, John H., Machine Co......691
Colonial Supply Co.......785-786-787
Contractors' Machinery & Supply Co. 428
Duquesne Electric & Mfg. Co....692
Fairbanks Co., The..............135
Flood City Mfg. Co.........658-659
Foster, L. B., Co................429
Green, L. A.....................431
Harris Pump & Supply Co........189
Lazarus, M. E., Co., The.......432
McCoy-Brandt Machinery Co.....695
Miller-Owen Electric Co., Inc....694
Railway & Mine Supply Co......791
Stine, J. C., Co., The...........344
Tranter Mfg. Co................795
Winterer, Herman L............696

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Ingersoll-Rand Co..............622
Pneumelectric Machine Co......623
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Fulton Tool Co.................798
Hardsocg, Martin, Co., The.......800
Hardsocg Mfg. Co...............801
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Leetonia Tool Co................799
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McCoy-Brandt Machinery Co.....695
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Marion Machine, Foundry & Supply Co. 196
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McCoy-Brandt Machinery Co.....695
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Wright Wire Co.................409

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Frick & Lindsay Co.........788-789
Hardsocg, Martin, Co., The.......800
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Electrical Material Co...........673
Electric Service Supplies Co..656-657
General Electric Co.............661
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Ohio Brass Co., The............662
Tracy Bertrand, P...............617
Union Electric Co...............681
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Sweet's Steel Co............424-425
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Carnegie Steel Co...............157
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Front Construction Co..........693
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Foster, L. B., Co...............429
Frank, M. K....................430
Front Construction Co..........693
Green, L. A....................431
Lazarus, M. E., Co., The........432
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RAILWAYS—Narrow Gauge.
Light Railway Equipment Co.....442

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Berger, C. L., & Sons............73
Buff & Buff Mfg. Co.............74
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Iron City Electric Co............675
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American Steam Gauge & Valve Mfg. Co......................273
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Electric Service Co., Inc., The....686
Doubleday-Hill Electric Co......684
Dudley Electric & Machine Co...685
Gee Electric Co.................674
Kester Electric Co..............676
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Buettner & Shelburne Machine Co., Inc. 618-619
Dudley Electric & Machine Co...685
Flood City Mfg. Co..........658-659
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Allen & Garcia Co................90
Fairmont Mining Machinery Co.92-95
Heyl & Patterson, Inc............97
Jeffrey Mfg. Co............100-101
Krehbiel Co......................99
Link-Belt Co....................104
Roberts Schaefer Co.............109
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Stephens-Adamson Mfg. Co.....111
Webster Mfg. Co.................112
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Mine Safety Appliances Co. 766-767-768
Safety First Supply Co...770-771-772

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Mine Safety Appliances Co. 766-767-768
Safety First Supply Co...770-771-772

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Iron City Electric Co............675
Miller-Owen Electric Co., Inc.....694
Tracy, Bertrand P..............617
Virginian Electric & Machine Works 687
Western Electric Co.........682-683

RHEOSTATS—Blasting Machine.
(See Blasting Supplies.)

RHEOSTATS (For testing blasting machines.)
Du Pont, E. I., de Nemours & Co. 736-737-738-739

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Trussed Concrete Steel Co....160-161

RIB METAL.
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Obemayer, S. Co. (The).........270
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KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

BY-PRODUCT COKE OVENS

IN UNITED STATES AND CANADA

AUGUST 1, 1917

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Bethlehem Steel Co., Sparrows Point, Md	120
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Brier Hill Steel Co., Brier Hill, O	84
Cambria Steel Co., Johnstown, Pa	92
*Carnegie Steel Co., Clairton, Pa	640
Coal Products Co.. Joliet, Ill	35
*Colorado Fuel & Iron Co., Pueblo, Colo	120
Dominion Iron & Steel Co., Sydney, N. S	120
Gulf States Steel Co., Alabama City, Ala	37
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Illinois Steel Co., Joliet, Ill	280
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*Minnesota By-Product Coke Co., St. Paul, Minn	60
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Toledo Furnace Co., Toledo, O	96
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Milwaukee Coal & Gas Co., Milwaukee, Wis	160
National Tube Co., Wheeling, W. Va	120
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Pennsylvania Steel Co., Lebanon, Pa	90
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Philadelphia Sub. G. & E. Co., Chester, Pa	40
Semet-Solvay Co., Syracuse, N. Y	40
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Chattanooga Coke & Gas Co., Chattanooga, Tenn.	12

WILLPUTTE TYPE.

Coal Products Co., Joliet, Ill	19
*Woodward Iron Co., Birmingham, Ala	60
Total	79

OTTO HOFFMAN TYPE.

Allegheny By-Products Coke Co., Glassport, Pa.	120
Camden Coke Co., Camden, N. J	150
Carnegie Steel Co., Farrell, Pa	212
Citizens Gas Co., Indianapolis, Ind	100
Dominion Iron & Steel Co., Sydney, N. S	520
Hamilton Otto Coke Co., Hamilton, Ont	100
Lackawanna Iron & Steel Co., Lebanon, Pa	228
Lackawanna Iron & Steel Co., Buffalo, N. Y	188
Michigan Alkali Co., Wyandotte, Mich	30
New England Gas & Coke Co., Everett, Mass	400
Northwestern Iron Co., Mayville, Wis	36
Zenith Furnace Co., Duluth, Minn	50
Total	2134

SUMMARY.

Gas Machinery	28
H. Koppers Company	5253
Otto Hoffman	2134
Roberts Type	12
Rothberg Type	281
Semet-Solvay	1649
Willputte Type	79
Total	9436

*Under Construction Aug. 1, 1917.

List of Coal Mine Inspectors in The United States

Corrected to September 1, 1917.

ALABAMA.

Chief Mine Inspector.
C. H. Nesbitt, 420 Chamber of Commerce Building, Birmingham.

District Mine Inspectors.
W. P. Smith, Tuscaloosa.
David Kelso, Wylam.
Hugh Lynch, Pratt City.
Thomas Roscoe, Jasper.
S. M. Thompson, Piper.

ALASKA.

U. S. Territorial Mine Inspectors.
Sumner S. Smith, Juneau.
W. J. Maloney, Asst., Nome.

ARKANSAS.

Chief Mine Inspector.
Thomas H. Shaw, Midland.

CALIFORNIA.

Chief Inspector.
H. M. Wolflin, 407 Underwood Bldg., San Francisco..

COLORADO.

Commissioner of Mines.
Fred Carroll. Denver.

State Inspector of Coal Mines.
James Dalrymple, Denver.

Deputy Inspector of Coal Mines.
F. N. Oberding, Louisville.
Henry King, Denver.
Jas. W. Graham, Lafayette.
A. E. Thompson, Denver.

IDAHO.

State Mine Inspector.
Robert N. Bell, Boise.

ILLINOIS.

State Inspector of Mines.
Evans Johns, Springfield.
Ben D. Roberts, Streator.
Thos. H. Devlin, Assumption.
Geo. L. Morgan, Pekin.
David Z. Thursh, Farmington.
J. E. Jones, Benton.
John Garrity, Riverton.
Archibald Frew, Gillespie.
John Kaney, Centralia.
William Hartman, Belleville.
John McClintock, Murphysboro.
J. W. Starks, Georgetown.
James S. Reid, Carterville.

Chief Clerk State Mining Board.
J. F. Morris, Springfield.

INDIANA.

Chief Deputy Inspector of Mines.
Michael Scollard, Indianapolis.

Assistant Deputy Inspectors.
Edward Church, Sullivan.
Jos. Fennell, Linton.
J. C. Wright, Booneville.
W. C. Moore, Clinton.
Chas. Fox, Terre Haute.

IOWA.

State Mine Inspectors.
W. E. Holland, Albia.
R. T. Rhys, Ottumwa.
Ed. Sweeney, Des Moines

Secretary to Iowa Mine Inspectors.
L. E. Stamm, Des Moines.

KANSAS.

Com. of Labor.
P. J. McBride, Topeka.

Deputy Mine Inspectors.
James Sherwood, Pittsburg.
Charles Pafsley, Pittsburg.
Martin Kotzman, Frontenac.
Fred Green, Columbus.
Thomas Turvey, Scranton.

KENTUCKY.

Chief Inspector of Mines.
C. J. Norwood, Lexington.

Assistant Mine Inspectors.
G. T. Sears, Central City.
H. S. Sizemore, Earlington.
J. W. Reed, Lexington.
R. D. Clere, Ashland.
J D. Cain, Pineville.

MARYLAND.

State Mine Inspector.
J. L. Casey, Frostburg.

MICHIGAN.

State Coal Mine Inspector.
Thos. Kanary, St. Charles.

MISSOURI.

Chief Mine Inspector.
George Hill, Bevier.

State Mine Inspectors.
Coal Mines.
Evan Jones, Higbee.
Ben. B. Fisher, Lexington.

MONTANA.

Chief Mine Inspector.
William B. Orem, Helena.

Assistant Mine Inspector.
D. J. McGrath, Butte.

State Mine Inspector.
John Sanderson, Helena.

NEW MEXICO.

State Mine Inspector.
W. W. Risdon, Albequerque.

NORTH DAKOTA.

State Engineer and Ex-Officio Coal Mine Inspector.
J. W. Bliss, Bismark.

OHIO.

Chief Deputy, Division of Mines.
L. D. Devore, (Majestic Theatre Bldg.) Columbus.

Deputy Mine Inspectors
Dan C. Jones, Coalton.
Jas. Dugan, Murray City.
J. T. Cox, Glouster.
Elmer Sagle, Roseville.
E. W. Smith, Byesville.
Saml. Jones, Magnolia.
J. P. Davis, Alliance.
F. P. Carey, Flushing.
W. B. Milgate, New Straitsville.
H. F. McCauley, Columbus.
Kebner McConnell, Columbus.

OKLAHOMA.

Chief Mine Inspector.
Ed. Boyle, Oklahoma City.

Assistant Mine Inspectors.
Tom Scott, Coalgate.
W. T. Williams, Krebs.
Frank Haley, Henryetta.

PENNSYLVANIA.

Chief of Department of Mines.
James E. Roderick, Harrisburg.

Anthracite Inspectors.
State Mine Inspectors.
P. J. Moore, Carbondale.
I. M. Evans, Scranton.
S. J. Phillips, Scranton.
Jenkin T. Reese, Scranton.
Augustus McDade, Rendham.
Hugh McDonald, Pittston.
T. J. Williams, Wilkes-Barre.
S. J. Jennings, Pittston.
D. T. Davis, Wilkes-Barre
Jos. J. Walsh, Nanticoke.
D. J. Roderick, Hazleton.
P. C. Fenton, Mahanoy City.
A. B. Lamb, Shenandoah.
J. A. O'Donnell, Centralia.
David T. Williams, Scranton.
Robert Johnson, Pittston.
John B. Corgan, Wilkes Barre.
Frank Kettle, Wilkes Barre.
John J. Strickler, Hazleton.
Keran Donohue, Pottsville.
B. I. Evans, Mt. Carmel.
P. J. Friel, Shamokin.
M. J. Brennan, Pottsville.
Chas. J. Price, Lykens.
Benjamin Maxcy, Forest City

Bituminous Inspectors
State Mine Inspectors.
Alexander McCanch, Monongahela.
C. B. Ross, Latrobe.
T. K. Adams, Mercer.
Elias Phillips, Dubois.
T. D. Williams, Johnstown.
C. P. McGregor, Crafton.
Joseph Knapper, Philipsburg.
P. J. Walsh. Connellsville.
J. J. McDonald, Greensburg.
Joseph Williams, Altoona.
Thos. A. Furniss, Punxsutawney.
William Langan, Elizabeth.
David Young, Freeport.
Alexander Monteith, Patton.
W. H. Howarth, Brownsville.
John I. Pratt, 7701 Frankstown Ave., Pittsburgh.
Thomas A. Mather, Tyrone.
James J. Stoker, Irwin.
F. W. Cunningham, Somerset.
C. P. Byrne, Charleroi.
John F. Bell, Dravosburg.
Edward E. Girod, Masontown.
Nicholas Evans, Johnstown.
Thomas S. Lowther, Indiana.
P. J. Callaghan, Bridgeville.
Harry Phythyon, Belle Vernon.
Thomas H. Thompson, Punxsutawney
P. S. King, 612 N. Canal St., Pittsburgh.
C. H. Crocker, Blairsville.

TENNESSEE.

Chief Mine Inspectors.
R. A. Shiftlett, Nashville.
L. E. Card, Coal Creek.
E. W. Mansfield, Rockwood.

TEXAS.

State Mine Inspector.
B. S. Gentry, Austin.

VIRGINIA.

Commissioner of Labor.
James B. Doherty, Richmond.

State Mine Inspector.
A. G. Lucas, Richmond.

WASHINGTON.

Chief Mine Inspector.
James Bagley, Seattle.

Deputy Mine Inspector.
Simon Ash, Seattle.

WEST VIRGINIA.

Chief of Dept. of Mines.
Earl A. Henry, Charleston.

District Mine Inspectors.
W. B. Riggleman, Fairmont.
F. E. Parsons, Clarksburg.
L. D. Vaughn, Grafton.
R. L. Jenkins, Logan.
R. B. Cobb, Charleston.
Geo. R. Cook, Thomas.
Andrew Calderwood, Charleston.
Eli J. Mason, Montgomery.
John I. Absalom, Montgomery.
L. B. Holliday, Beckley.
R. B. Erskine, Bramwell.
L. G. Bray, Williamson.
J. G. Vaughn, Fayette.

WYOMING.

State Coal Mine Inspectors.
George Blacker, Cumberland.
G. W. Akin, Sheridan.
Isaac M. Davies, Lansford.
John Curran, Pottsville.

IF YOU DO NOT FIND WHAT YOU
WANT IN THE MINING
CATALOGUES
WRITE
US

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

DEVELOPMENT AND ENGINEERING SECTION

The following concerns have catalogue descriptions in this section:

- Berger, C. L. & Sons.
- Buff & Buff Mfg. Co.
- Cement Gun Co., Inc.
- Drake, A. W. Drilling Co.
- Dravo Contracting Co.
- Economy Drawing Table Co.
- Elliott, B. K. Co.
- Heller & Brightly.
- Hoffman Brothers.
- Metallurgical Laboratory, The.
- Pease, C. F. Co.
- Punxsutawney Drilling & Contracting Co.
- Randolph-Means Co.
- Richards, J. R.
- Sullivan Machinery Co.

For additional descriptions of Development and Engineering Companies not appearing in this section, refer to Index of Products in front of book

A. W. DRAKE DRILLING COMPANY

712-713 Markle Bank Building
HAZLETON, PA.

Drilling & Water Supply Contractors

Our Specialty---Drilling Holes of Large Diameter

"Holes Drilled Any Size, Any Depth, For Any Purpose, Anywhere."

Products

Bore-holes for rope-ways, column pipe, steam pipe, air pipe and exhaust pipe in mines, tunnels and subways, for flushing mine workings with culm or other substances, for ventilation and exits from mines.

Bore holes for plunger elevators.

Water systems for cities, towns, manufacturing plants and country homes.

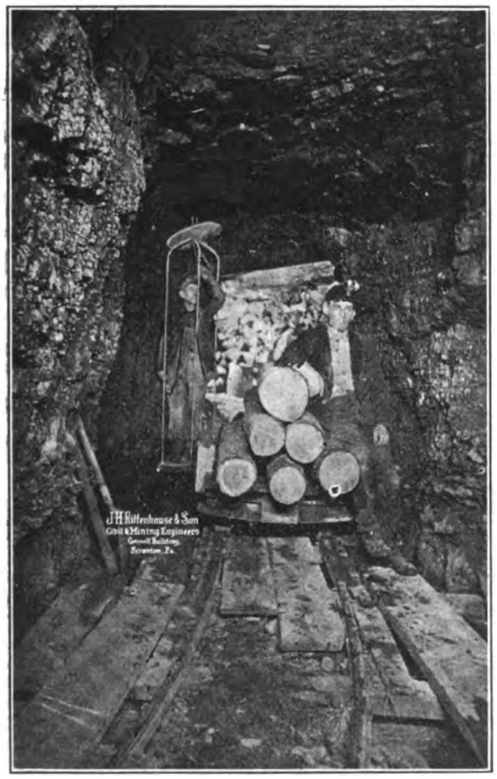
Artesian wells drilled and tested.

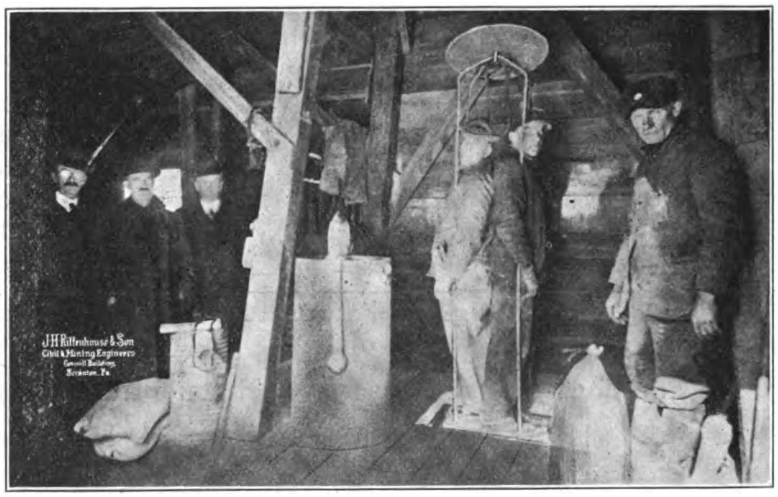
We have drilled holes 30" in diameter to a depth of 600 ft., and 24" in diameter ranging in depth from 200 ft. to 750 ft.

The two photographs below show the bottom of a 24" hole down through which a lot of timber and two men have been lowered, and also the top of the same hole with two men on the cage who have just come up through the hole together.

This 24" hole was drilled for the Pennsylvania State Armory Board at the Armory in Scranton, Penna., and is used for taking materials into the workings for use in building artificial supports for the surface which had caved and damaged the Armory.

At one time fifteen men who had been working at these supports when they finished for the day and started to come out found their exit cut off by water which had suddenly broken into the mines. In pairs, the men were then hoisted safely through the 24" hole 142' to the surface.





Views of hoisting men through 24" bore hole drilled for the Pennsylvania State Armory Board at Scranton, Penna.

HOFFMAN BROS.

1 Eberhart Building
PUNXSUTAWNEY, PA.

Contractors, Diamond Core Drilling

Our Speciaity---Testing Bituminous Coal Lands

Successful Coal Mining
is dependent upon a number of conditions, none of which is more important than the preliminary work and examination of property values.

We Furnish Data

through our DIAMOND DRILL RECORDS, which enables you to estimate land values and invest wisely. These records further enable your engineers to make your plans for a SUCCESSFUL OPERATION.

To Carry Insurance Is Good Business

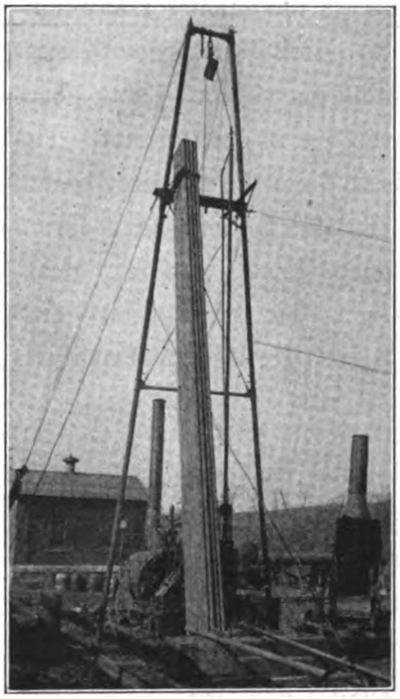
Diamond Drilling is your insurance against possible failure. Allow us to prove to your entire satisfaction, THE VALUE OF YOUR PROPERTY, by removing for you 2¼" cores through all strata and GUARANTEEING SATISFACTORY COAL CORES. This gives you INSIDE INFORMATION for your benefit and no one else. Is it not better to spend the interest on your principal than to invest your principal and lose it?

Ours Is a Business of Service

Through all of these years, it has been our aim to so equip ourselves that we should be prepared to render our patrons the very best possible service at the lowest possible cost. With this object in view, we have devoted our entire time and energy in PREPAREDNESS FOR SERVICE.

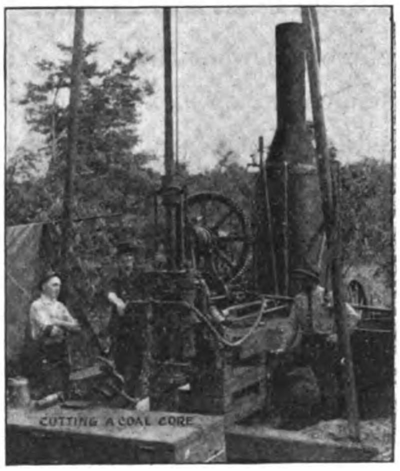
With Twenty-two (22) Completely Equipped Diamond Core Drills
all especially adapted for drilling Bituminous Coal, and the full advantages of the very best machine shop work, our facilities for service cannot be questioned.

We Have a Strong Organization of Diamond Drillers Who Are Thoroughly Competent and Reliable



These men are in our employ year after year, and have developed the skill and ability necessary to do work quickly and accurately. We do contract work in the Winter as well as in the Summer. We are pleased to have small contracts from responsible firms, as they afford us an opportunity of becoming acquainted, and also enable us to keep our drillers busy between the larger contracts.

Our Reputation as Successful Diamond Drillers
has been built up through a large list of successful Coal Operators and Mining Engineers who call on us year after year for their Diamond Drill Work. Many of the most prominent Coal Companies and Mining Engineers of the Bituminous Coal Fields know us through the development and prospecting of many different properties during the last fifteen years.



WE SOLICIT YOUR INQUIRIES. WE NEED YOUR BUSINESS AND WE CONFIDENTLY BELIEVE YOU WILL WANT TO TAKE ADVANTAGE OF OUR FACILITIES FOR SERVICE.

Punxsutawney Drilling & Contracting Co.

Weber Building, Punxsutawney, Pa.

Hans Olson, President

John A. Fisher, Secretary & Treasurer

Testing mineral lands with the diamond drill is now acknowledged to be the only satisfactory way. In this advanced age of keen competition it would be considered poor business judgment for any individual or corporation to purchase a property supposed to be rich in minerals without being absolutely certain as to whether it does or not. The only way to find out is to have the property tested by the diamond drill. By this method you secure a core of the entire distance drilled. Accurate measurements of all strata passed through are furnished, and a complete core for chemical analysis is the final result.

Testing Coal Land Is Our Business

We are the pioneers in the diamond drilling business in Pennsylvania. We have gone through all phases of the business, and believe we have gleaned a pretty thorough knowledge of how to do the work right in our twenty-five years' experience. SO CONFIDENT ARE WE OF OUR ABILITY THAT WE GUARANTEE SATISFACTION.

Selecting a man to test your mineral lands is just as important as selecting your lawyer or your doctor—you want the best. You cannot afford to take a chance on inexperienced or incompetent men in either case. Our ability is unquestioned and our prices for the work are reasonable. We have plenty of drills and a force of skilled workmen at all times and can take care of your work on short notice. With the best machinery on the market and a force of experienced, reliable workmen, most of whom have been with us a greater part of the twenty-five years we have been testing coal lands, we have an organization that can produce results.

Our best advertisement has been the satisfactory service we have rendered some of the largest concerns in the United States, any of whom you are at liberty to write concerning our reliability. For your information and convenience we mention a few of these as follows:

PENNSYLVANIA

Berwind-White Coal Mining Co.	Philadelphia, Pa.
Rochester & Pittsburgh Coal & Iron Co.	Punxsutawney, Pa.
Buffalo & Susquehanna Coal Mining Co.	Dubois, Pa.
Northwestern Mining & Exchange Co.	Dubois, Pa.
Merchants Coal Co.	Pittsburgh, Pa.
Clearfield Bituminous Coal Corporation	Clearfield, Pa.
Keystone Coal & Coke Co.	Greensburg, Pa.
Pennsy Coal Co.	Franklin, Pa.
E. V. d'Invilliers, Mining Engineer	Philadelphia, Pa.
J. S. Sillyman & Co., Mining Engineers	Altoona, Pa.
John F. Torrence	Connellsville, Pa.
E. W. Eisler	Butler, Pa.

OHIO

American Sheet & Tinplate Co.	Pittsburgh, Pa.
George M. Jones Co.	Toledo, O.
W. H. Warner & Co.	Cleveland, O.

ILLINOIS

Cleveland, Cincinnati, Chicago & St. Louis Ry.	Chicago, Ill.

WEST VIRGINIA

Consolidation Coal Co.	Fairmont, W. Va.
Davis Coal & Coke Co.	Cumberland, Md.
Elkins Coal & Coke Co.	Morgantown, W. Va.
New River & Pocahontas Consolidated Coal Co.	Charleston, W. Va.
Faraday Coal & Coke Co.	Gary, W. Va.
Virginia-Pocahontas Coal Co.	Johnson City, Tenn.
New River Collieries Co.	Eccles, W. Va.

KENTUCKY

West Kentucky Coal Co.	Sturgis, Ky.

We would be pleased to submit prices on your next contract for drilling. A telegram, postal card or telephone call will bring our representative to you.

J. R. RICHARDS

INDIANA, PA

Diamond Drill Contractor

Take no Chances

Test your property before you spend a lot of money in developing it and find that you do not have the quanity and quality that you had expected. I have known of a good many instances of the coal showing up good on the outcrop and after headings had been driven back into the hills the coal had pinched down to a thickness that it was too thin to work and a great amount of money had been spent for plant and equipment which had to be dismantled, where in the first place if several drill holes had been drilled it would have saved all this expense.

Diamond Core Drilling.

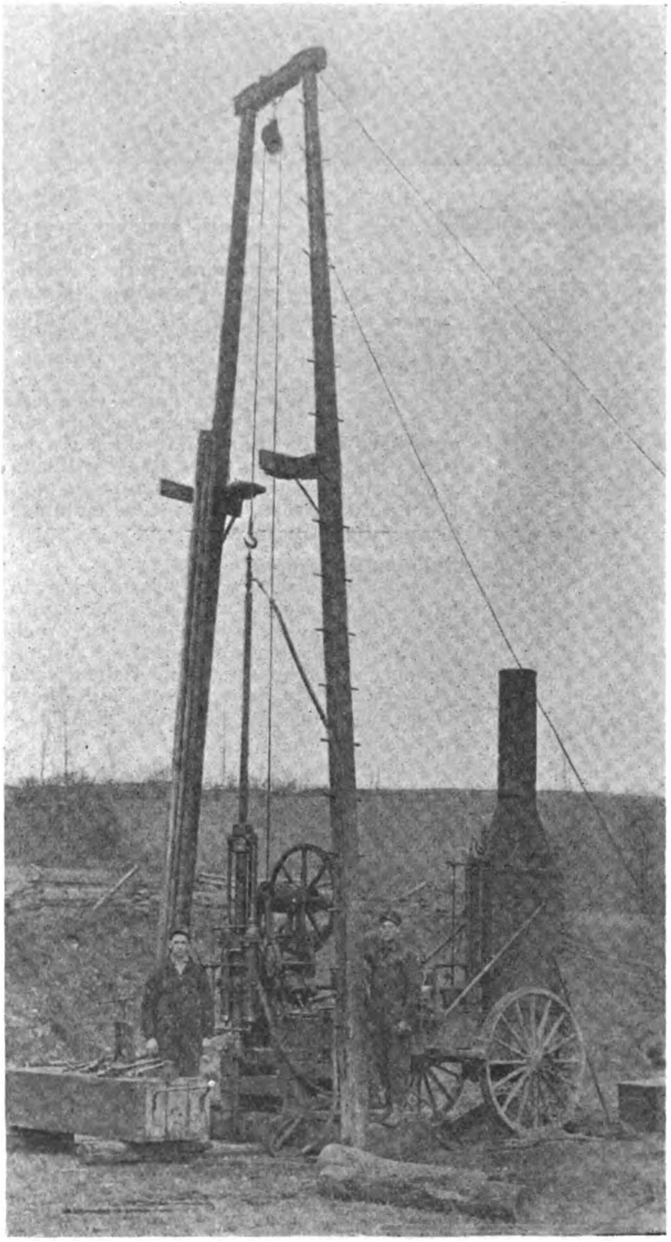
To do this work I have a complete equipment and crews of experienced drillers who have been with me for 15 years. You may well take advantage of their experience.

I have been in the Diamond Drill business for 26 years and have done work for the largest Operators in United States to any of whom you may inquire concerning my work.

For your information I will mention a few of these as follows:

Berwind White Coal Mining Co., Philadelphia, Pa.
Rochester Pittsburg C. & I. Co., Punxsutawney, Pa.
Cambria Steel Co................Johnstown, Pa.
Pa. Coal & Coke.....................Patton, Pa.
Beaverdale Coal Co...............Beaverdale, Pa.
Maryland Coal Co..............Cumberland, Md.
Graff Coal Co....................Blairsville, Pa.
Struthers Furnace Co...............Struthers, O.
Oak Ridge C. & C. Co...............Hastings, Pa.
W. P. Rend & Co...................Chicago, Ill.
Glenwood Coal Co..............Philadelphia, Pa.
Cymbria Coal Co...............Philadelphia, Pa.
Jos. G. Beale....................Leechburg, Pa.
Kennerly Coal & Coke Co........Philadelphia, Pa.
Mifflin Coal Co.................Pittsburgh, Pa.
Empire Coal Co.................Philadelphia, Pa.
Corrigan McKinney................Cleveland, O.
Operators Coal Mining Co.........Johnstown, Pa.
Clark Brothers Coal Co..........Philadelphia, Pa.
Haws Coal Co..................Johnstown, Pa.
E. H. Jennings Bros..............Pittsburgh, Pa.
Loyal-Hanna Coal & Coke Co.....Philadelphia, Pa.
Graceton Coke Co..................Graceton, Pa.
J. V. Thompson.................Uniontown, Pa.
Clearfield Bituminous Coal Corp....Clearfield, Pa.

I would be pleased to submit prices on your next contract for drilling.



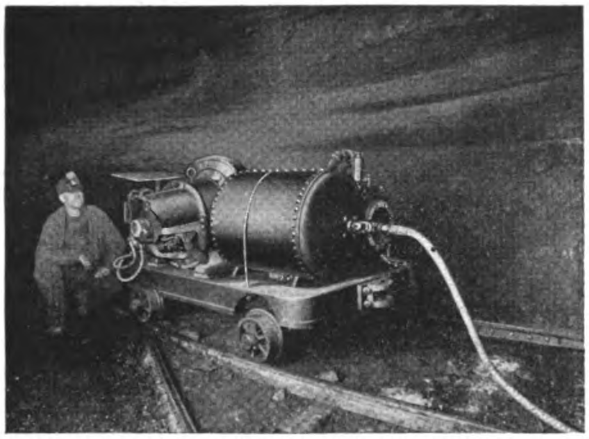
SULLIVAN MACHINERY COMPANY

General Offices, 122 So. Michigan Ave., Chicago, U. S. A. Works: Chicago; Claremont, N. H.

BOSTON
BUTTE
DENVER
EL PASO
HUNTINGTON
JUNEAU
KNOXVILLE
LONDON
NEW YORK
PARIS
PITTSBURGH
SCRANTON
ST. LOUIS
SALT LAKE
SPOKANE
SYDNEY
VANCOUVER
PETROGRAD

Rock Removal

Diamond Drilling



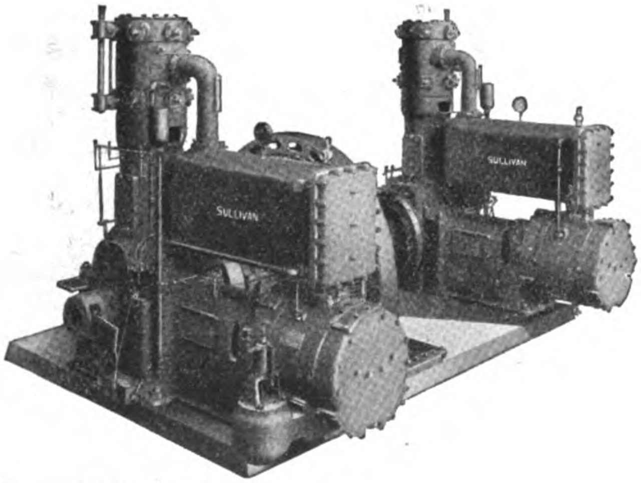
Rock removal is performed in the modern coal mine with a **Sullivan Portable, Motor Driven Air Compressor** and one or more **Sullivan Rotator Hammer Drills.** The "WK-2" compressors are complete and independent and run anywhere in the mine that rails can be laid. Built in four sizes, they will run a post puncher or a pick machine or two, for heading work, as well as hammer drills. Bulletin 75-AD.

Sullivan Rotators

Are of several types, for boring in hard or soft rock or in coal. Two styles of mountings are available. Any rock drilling, from brushing roof or lifting bottom up to heavy tunnel driving can be done quickly and cheaply with these 38-lb., one-man tools. Bulletin 70-AD.

Sullivan Air Compressors

For permanent service at coal mines, Can be had in a variety of steam, belt or motor driven types. This cut shows the most modern compressor on the market, the Sullivan "WN-4", twin angle compound, with direct motor drive and three-pass intercooler. Capacities, 800 to 2,200 cu. ft. Booklet 115-D.



Core Drilling By Contract With Sullivan Diamond Core Drills

Cores removed by Sullivan Diamond Drills.

When examining coal lands, write to the Contract Drilling Department of this Company for prices and expert advice. We have been in the drilling business since 1884, and are ready to undertake coal prospecting at any time and anywhere, with up-to-date Sullivan Diamond Drills and the latest appliances for recovering the fragile coal core complete.

Sullivan Drilling Records

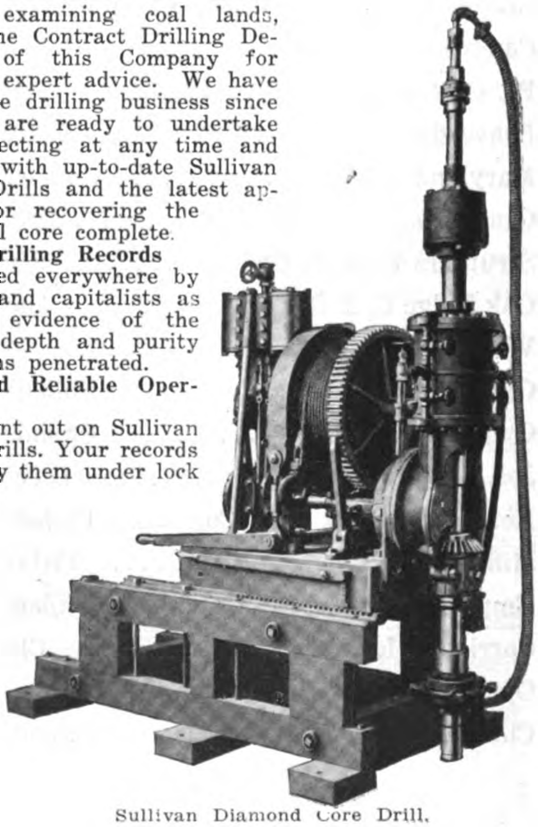
are accepted everywhere by engineers and capitalists as conclusive evidence of the thickness, depth and purity of the veins penetrated.

Skilled and Reliable Operators

only are sent out on Sullivan Contract drills. Your records are kept by them under lock and key.

SEE US BEFORE YOU DRILL.

Booklet 113-D.



Sullivan Diamond Core Drill.

THE DRAVO CONTRACTING CO.

Diamond Bank Building, Pittsburgh, Pa.

Engineers and Contractors - Shaft Sinking

Slopes, Tunnels, Complete Mining Plants, Pneumatic Caissons, Submarine Construction, Dams, Sea Walls, Bridge Piers,
All-Steel Coal Barge and Steam Boat Construction

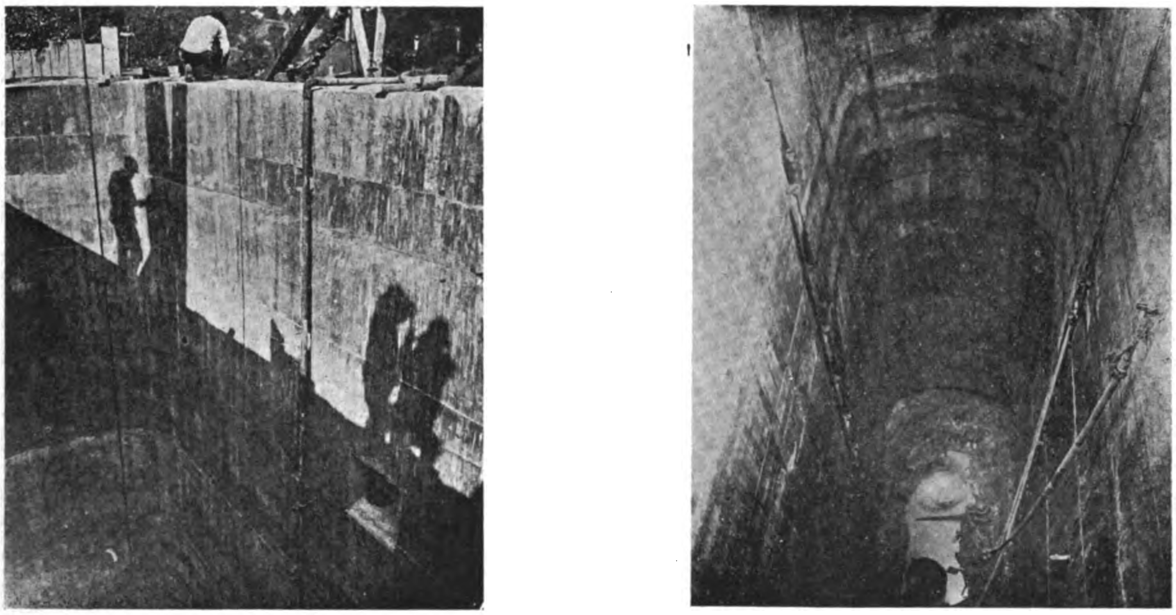
In the last fifteen years we have sunk over 50,000 feet of shafts—nearly 9½ miles. This volume of sinking under so many varied conditions has given us the opportunity for the successful development of a process of sealing water-bearing rock strata by cementation, enabling us now to guarantee a practically dry shaft in even the wettest country.

Our biggest work in the shaft line was the sinking and water-sealing of 26 shafts on the new 70-mile Catskill Aqueduct for New York City—over 50 per cent. of the total on the entire waterway—their depth ranging from 200 feet to 700 feet. Our work has carried us to every coal mining State in the East, and, while the most of our sinking has been for the older and larger mining interests, such as Frick Coke Company, Berwind-White Coal Mining Company, Ellworth Collieries Company, Thompson Connellsville Coal & Coke Company, Vesta Coal Company, Union Collieries Company, Youngstown Sheet & Tube Company, Bessemer Coal Coal & Coke Company, Consolidation Coal Company, and their various allied interests, for whom we have sunk 35 shafts, we have put down over 85 openings for companies new in their fields.

While our shaft-sinking department handles probably only one-third of our annual business, we have under contract at the present writing more footage than that of all the other shaft contractors combined.

Our large repair and structural shops on our 20-acre property on Neville Island, near Pittsburgh, enable us to keep our plant in first class condition. A store of dry sand and gravel kept constantly to a 70,000-ton pile by one of our own sand dredges, a quantity of lumber and timber ranging between three hundred and five hundred thousand feet, and a well-balanced stock of pipe and fittings and small tools, have made our yard a valuable means for gaining not only a quick start, but a sure and prompt source of supply.

These few facts are presumably some of the reasons why we have done the big bulk of the recent shaft sinking in the East.



Shafts No. 4 and No. 5 Vesta Coal Co.

CEMENT-GUN COMPANY, INC.

So. 10th and Mill Streets, Allentown, Pa. New York Office, 30 Church Street

E. R. Ayers, 1414 Fisher Bldg., Chicago, Ill.
John A. Traylor, Newhouse Bldg., Salt Lake City, Utah.
Taylor Engineering Co., 538 Central Bldg., Seattle, Wash.
Taylor Engineering Co., Vancouver, B. C.

FOR OVEN REPAIRS THE CEMENT-GUN METHOD IN THE COAL MINE

The Cement-Gun method of repairing coke ovens while hot, of preventing roof slacking, of fire protection and of building construction is the rational way, the permanent way and the economical way.

The Cement Gun Mounted on Mine Truck.

At the Coke Ovens

Mr. H. V. Paterson says in reference to the Cement Gun in Coke Oven repair: "Briefly, the Cement Gun is a necessary adjunct to all coke oven plants because of the speed, accuracy and excellent manner in which the work can be done, as well as its ability to reach points that are inaccessible to hand work on account of the heat."

IN SUCCESSFUL OPERATION AT

Citizens Gos Co. of Indianapolis	One	Dover By-Products Coke Co.	One
Bethlehem Steel Company	One	Milwaukee Coke and Gas Co.	One

Send for Bulletin No. 101; it tells the story.

At the Coal Mines

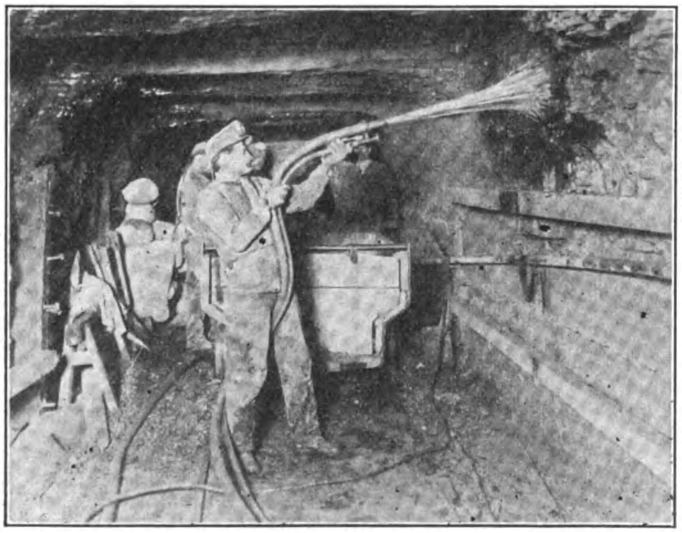
In a Report by Mr. L. M. Jones, E. M., Engineer in charge of the Coal Mining Dept. of the Bureau of Mines:

"At the time that the 'Guniting' was done, there was marked indications of slacking taking place along the sides of the entry, and along the uncovered portions this now exists to a considerable degree. In the covered portions, however, there is no indication of slacking, as the sides are entirely unbroken and there has been no scaling."

This Cement Gun work was done in the entry where the Bureau was carrying on their explosion tests and was subjected to at least three explosions per week for about eight months.

USED BY THE FOLLOWIN COAL COMPANIES

Acadia Coal Company	One
Chattanooga G. & C. Products Co.	One
Clearfield Bituminous Coal Co.	One
Consolidated Coal Co.	One
Consolidation Coal Co.	One
Delaware & Hudson Co.	One
Dominion Coal Co.	One
Elk River Coal and Lumber Co	One
Forty Fort Coal Company	One
Lehigh Coal & Navigation Co.	One
Lehigh Wilkes-Barre Coal Co.	One
Litz Smith Island Creek Coal Co	One
Locust Mountain Coal Co.	One
Moffat Coal Company	One
P. & R. Coal and Iron Co.	Seven
Racket Brook Coal Co.	One
Tennessee Coal & Iron Co.	Two
Union Pacific Coal Co.	One
United Coal Corporation	One
Valley Camp Coal Co.	One
Washington Coal & Coke Co.	One



Preventing Roof Slacking.

Get Bulletin No. 107.

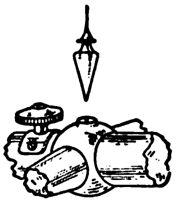
Send for the full set of bulletins and learn the whole story of the Cement Gun and its product Gunite.

C. L. BERGER & SONS

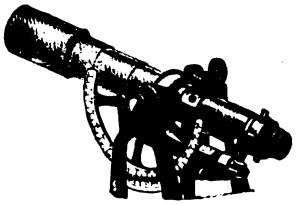
BOSTON, MASS., U. S. A.

The Berger Standard Transits for Collieries

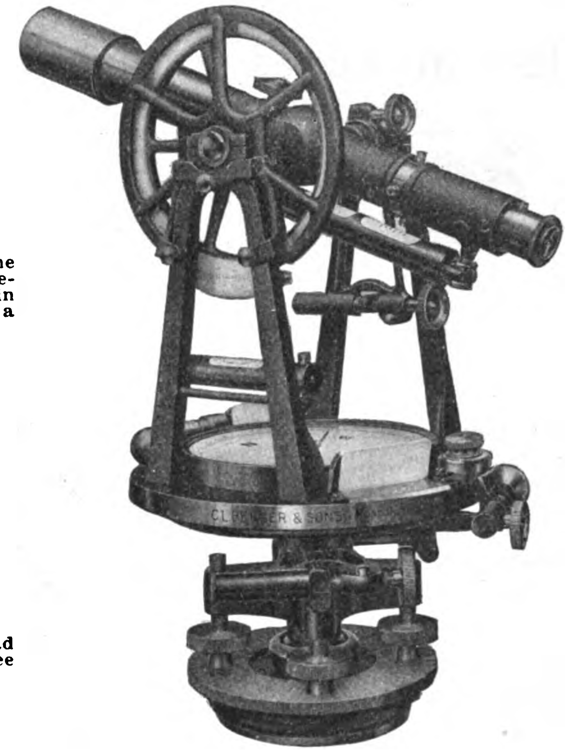
Regularly Made in Five* Sizes as in cut below.

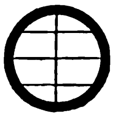


On a round hub of small diameter the center point is located on the telescope's axis to better distinguish it in dark places when centering under a point above the transit.



For transits with vertical arc instead of full vertical circle and guard. See below.





The non-adjustable stadia wires accurately spaced and fixed to diaphragm in ratio 1:100.

Prism with colored glass attachable to eye piece cap.

Price $8.00.

Reflector-Shade.

Price $4.00.

MINE TRANSITS		No. 5† (UNUSUAL LARGE SIZE)	No. 6†† (USUAL SIZE)	No. 4½	No. 4
HORIZONTAL LIMB	DIA. AT EDGE OF GRADUATION	6¼"	5⅛"	4½"	4"
	READING TO	MINUTES	MINUTES	MINUTES	MINUTES
VERTICAL LIMB	DIA. AT EDGE OF GRADUATION	5 INCH	5 INCH	4 INCH	4 INCH
	READING TO	MINUTES	MINUTES	MINUTES	MINUTES
NEEDLE	LENGTH	4¼ INCH	3¾ INCH	3 INCH	2½ INCH
TELESCOPE	KIND AND LENGTH	11½ IN. (ERECT.¶)	10¼ IN.	8 IN. (INVERT.¶¶)	7½ IN.
	APERTURE	1¼ INCH		1⅛ INCH	
	POWER	24 DIA.	18 DIA.	18 DIA.	18 DIA.
SPIRIT LEVEL TO TELESCOPE, LENGTH		5½ INCH		4 INCH	
TRIPOD	WITH ALUMINUM CAP	EXTENSION	EXTENSION	EXTENSION	EXTENSION
WEIGHT OF	TRANSIT	ABOUT 14½ LBS.	ABOUT 11 LBS.	ABOUT 6½ LBS.	ABOUT 5 LBS.
	TRIPOD	" 11 "	" 11 "	REGULAR SIZE 10 LBS. LIGHT WEIGHT 8 LBS.	
	INSTRUMENT AND TRIPOD PACKED	" 70 "	" 60 "	ABOUT 55 LBS.	ABOUT 55 LBS.
	FOR SHIPMENT IN TWO BOXES.	" 32 KILOS	" 27 KILOS	" 25 KILOS	" 25 KILOS
CODE WORD		IBERIS	LABURNUM	GENILA	GENISTA
PRICE		$260.00	$260.00	$247.00	$247.00

GENERAL SPECIFICATIONS for above Transits

For size, weight and particulars see table

STERLING SILVER GRADUATIONS, Double opposite Verniers to read to Minutes, two rows of black figures in opposite directions from 0 to 360 degrees, figures on limb and verniers inclined in the direction they should be read. Vertical Circle with one double vernier reading to minutes with Aluminum Guard.

Magnetic needle made of Tungsten steel. Repeating centers long, stout, and of hard, frictionless metals. Telescope, leather finish. Stadia wires, Ratio 1: 100. Dust Guards to Object and Eye Piece focussing slides. Spirit Level and Clamp to Telescope. Shifting center for setting transit over or under a given point. Water-tight compass-box.

Tripod with Aluminum Cap, Mahogany box, Plumb Bob, Magnifying Glass, Spanner Wrench, Screw Driver and Adjusting Pin.

VARIATION PLATE, with arrangement for **INSTANTANEOUSLY** setting off **ANY** declination East or West. Price extra $10.00.

For other graduations and attachments see complete catalog.

Code words underlined designate transits kept in stock.

☞ **TRANSITS, IBERIS LABURNUM** but with an Arc of same size, in place of the full vertical circle and guard. Price, $13.00 Less. Add to Code, name ARC

☞ **TRANSITS GENILA | GENISTA** but with an Arc of same size, in place of the full vertical circle and guard. Price, $9.00 Less. Add to Code, name ARC

*Note—**Transit, Size No. 5½** of style shown, but not classified above, is **made to order only.** We strongly recommend our **Monitor Type Transit No. 5½,** which is kept in stock. It also has a compass with 3½" needle. Price is the same. (Cuts and description may be had)

† **Transit,** size **No. 5. Unusual large** size for **Ore Mining** but is extensively used in **Coal Mines, Tunnels** and **Sewer Work.**

†† **Transit,** size **No. 6. Usual** size for **Ore Mining.**

¶ **Inverting Telescope** for **No. 5. Furnished with above transit 11½" long, aperture 1¼", power 28 dia.**
Inverting " " **No. 6.** " " " " **10¼"** " " **1¼", power 22 dia.**
no extra charge, made to order only. Add to Code, word "**Inverting**"

¶¶ **Erecting Telescope** for **No. 4½. Furnished with above transit 8" long, aperture 1⅛", power 19 dia.**
Erecting " " **No. 4.** " " " " **7½"** " " **1⅛", power 18 dia.**
no extra charge, made to order only. Add to Code, word "**Erecting**"

BUFF & BUFF MANUFACTURING CO.

Main Office,
Jamica Plain Station, Boston, Mass.

Branch,
50 Church Street, N. Y. C.

Branch,
1737 Monadnock Block, Chicago

Specialists on Surveying Instruments

Products

"Buff" Surveying Instruments; Transits and Levels.

Also, Theodolites; Tripods; Levelling Rods; Plumb-Bobs; Plummet Lamps; Steel Tapes; Range Poles; Marking Pins, and Current Meters.

Permanent Accuracy

—the one thing the Engineer **must** have, is insured by the Buff experience of **fifty years** of successful Instrument-Making.

The Chief Engineer of a great Canadian Railway System writes us: "There is no doubt but you produce the best instrument made on the American continent."

Please investigate the Buff before you purchase!

Directions for Ordering

Order (especially triangulation transits) as long beforehand as possible, to insure careful construction if not in stock. State plainly style, size, kind of finish, price, shipping directions, name of express company, etc.

Repairs to Instruments

"Buff" Transits, solidly built to resist blows and falls, have metal generously distributed thruout the construction. At the Jamaica Plain Shops, all makes are put in good order and adjustment.

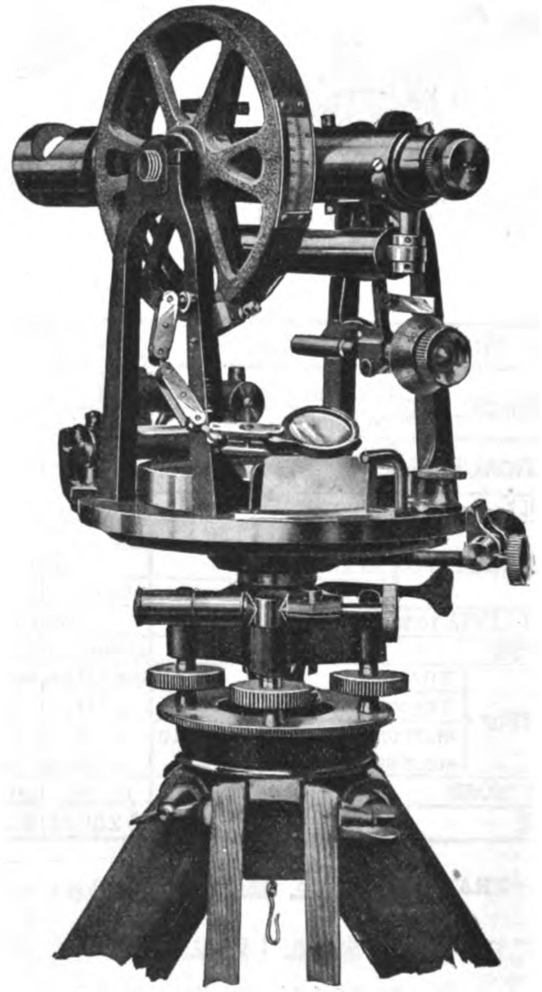
Injured parts of instruments are duplicated from stock in hand. Parts to be repaired should be pointed out in detail. When so ordered, all instruments are put into "thoro order and adjustment" at lowest expense.

References

This company are Instrument Makers to the United States Government, many departments; N. Y. C. R. R.; N. Y., N. H. & H. R. R.; New York Water Board; Public Servicce Commission, New York City; Board of Public Works, New York City; Standard Oil Co., Guggenheim and Rothschild interests, J. G. White Co., and numerous other engineering organizations.

The Pennsylvania R. R. used "Buff" instruments in large numbers in both their North River and East River Tunnels. The Subway Commission of New York are now using 250 "Buff" instruments.

B. K. Elliott Co., 126 Sixth St., Pittsburg, Pa., have a full line of Buff Mining Instruments in stock for convenience of engineers in Pennsylvania, Ohio, and West Virginia.



The Buff Precise Mine Transit
No. 3Q. $224.

The strongest, most accurate line of Mining Instruments. All types and sizes. All the latest improvements.

Send for Catalog No. 92, to Boston, Mass.

Use a Buff for Accuracy.

B. K. ELLIOTT COMPANY

126 Sixth Street, Elliott Building
Pittsburgh, U. S. A

Engineers' Supplies

Products

Drawing Paper, Blue Print Paper, Profile and Cross-Section Paper, Drawing Instruments, Protractors, Slide Rules, Polar Planimeters, Parallel Rulers, Scales, Triangles, Filing Cases, Drawing Boards and Tables, Pens, Inks, Field Books, Tapes, Plumb Bobs, Engnieers' Levels, Level Rods, Mine Spads, Anemometers, Transits, Text Books, Etc.

Drawing Paper

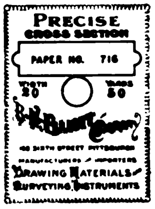
Drawing paper of the standard makes, Whatman, Strathmore, Ohio, in sheets, and Cecil, Alton, Iron City, and Brazillian papers in rolls. In addition we handle the standard mounted papers for mapping. A sample book of our papers will be sent on application.

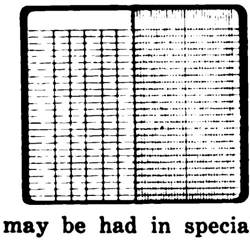
Blue Print Paper

We furnish Blue Print Papers, Superb, Penn and Fulton, sensitized with either of three solutions, Extra Rapid and Wunminit for electric blue printing machines, and Regular, for sun prnting; also Blue Print Cloth. All paper can be furnished in any size, 100 yards continuous rolls if desired, or in sheets of any size cut to order.

Cross-Section Paper

"Precise" profile and cross-section papers and cloths, with orange and green lining in the common graduations and in metric ruling. These are furnished in sheets, or in contnuous rolls up to 50 yards. Profile books for road or railroad profile and cross-sections carried in stock.





Field Books

Standard Field Books, Duplicating Field Books, Transit Books, Level Books, Cross-Section Books. Our books are leather bound, and are thread sewed and reinforced with muslin, making them much stronger than the wire sewed books now on the market. Other style field books than those listed may be had in special orders of not less than six dozen.

Pens and Inks

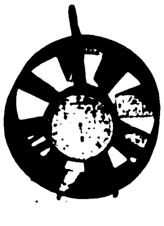
Pens, Inks, Pencils, of every kind used in the drawing room. All kinds of special pens, railroad pens, lettering pens, shading pens. We carry all shades of drawing ink, in ¾-oz. (regular size), half-pint, pint and quart size bottles. The cut shows one of the ink-bottle holders sold by us.

Triangles

Our Triangles are made of thoroughly seasoned materials; on all kinds the workmanship is the best, and perfect accuracy is assured. We make Mahogany, Ebony Lined and Transparent Amber Triangles with the regular angles and with special angles for special purposes.

Anemometers

Anemometers for the measurement of air currents are necessary to test the efficiency of the fans and the ventilation system. By them the quantity of air moving through a passage can be accurately measured, thus determining whether the ventilation is up to the legal requirement.



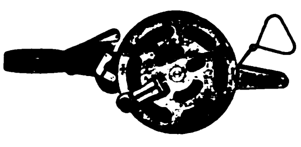
Filing Cases and Drawing Tables

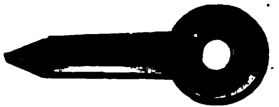
Filing Cases, Steel or Wood, for the filing of maps, drawings, tracings, etc., are indispensable in any but the crudest office system, and form one of the important parts of the equipment in up-to-date drawing rooms. In the case shown the drawers fit in grooves, there being no rails, and all the joints are dovetailed. The back of each drawer is covered with a thin strip six inches wide to prevent the drawings curling up.

Our line of drawing boards is complete. We have every size from 12 by 12 in. Army sketch board to the 10 by 12 foot office tables. All material used is true clean wood, well seasoned.

Tapes

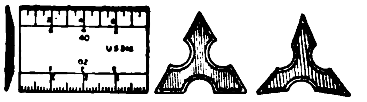
Our line of measuring tapes includes all of the best known makes: Lufkin, Chesterman and others. The Lufkin steel and metallic pocket tapes and longer chain tapes are standard among surveyors. The cut shows the Lufkin "Cripple Creek" reel, built for chain tapes. The reel is aluminum, the frame nickel plated steel. A boxwood spool fits into the reel and causes the tape to wrap evenly and tightly, and keeps it in place.





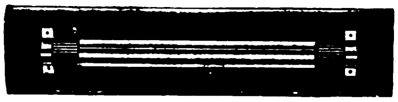
Spads

Our mine spads are accurately made, the hole being punched in the middle of the head, and each one is perfect. They are made in three sizes, 1¼", 2" and 2½".



Scales

We make and sell every scale used or needed by the engineer or surveyor. The material used is the best boxwood, and graduations are guaranteed correct. Our white edge scales are made of thoroughly seasoned boxwood and have the graduations on white inlaid celluloid, thus showing the graduations very distinctly.



Transits

Our transit department is one of the finest; we handle only the best. The names Buff & Buff, and Gurley have long been synonymous with fine instruments. Space here is inadequate to give in detail the description of any of these instruments, but detailed information can be found in our catalogs. In our transit department we have, as well, leveling instruments, compasses, pocket transits, and levels, etc.

Instrument Repairing

Our factory is equipped to make repairs promptly on short notice. Steel chains and tapes are repaired promptly in the most approved manner at moderate prices. Transits, Levels, etc., are repaired and re-adjusted at reasonable charges.

WRITE FOR COMPLETE CATALOG "K".

HELLER & BRIGHTLY

Corner Spring Garden Street and Ridge Avenue
PHILADELPHIA, PA.

Since 1870

Manufacturers of

Surveying Instruments

Products.

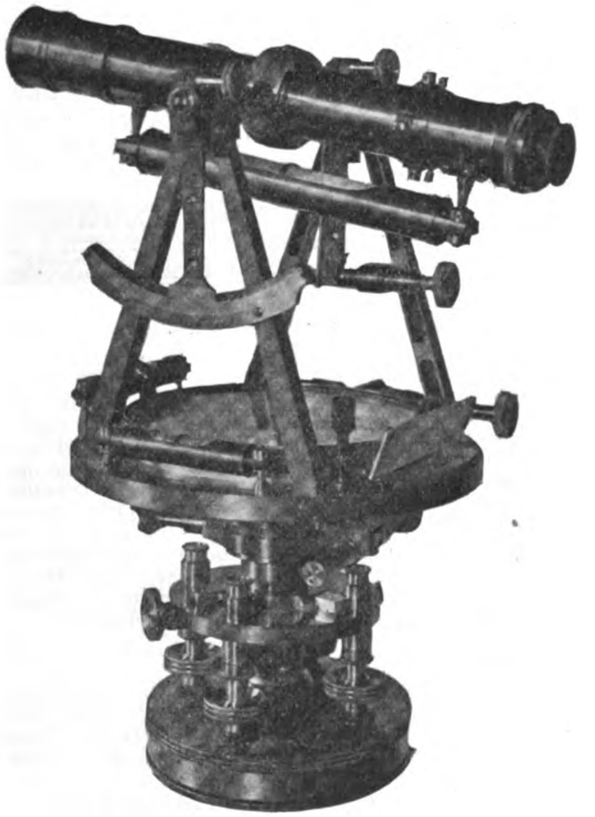
High-Grade Civil Engineer's TRANSITS and LEVELS.

General Description.

All Transits, strong and rigid, are made in three sizes; levels, in two; and are tabulated as shown in specification table. These instruments are absolutely accurate, stand up under all conditions, and adjustments remain perfect.

Special Features—Aluminum tripod head. Leveling head is detachable from instrument proper and tripod. Can be left on tripod or placed in carring box when not in use. This attaching causes no interference with adjustments, as clamping arrangement ensures a rigid union. In field, where frequent setting up is required, work is facilitated, and carring weight is more equally distributed. When two transits or a transit and level are purchased, the tripods can be made to interchange.

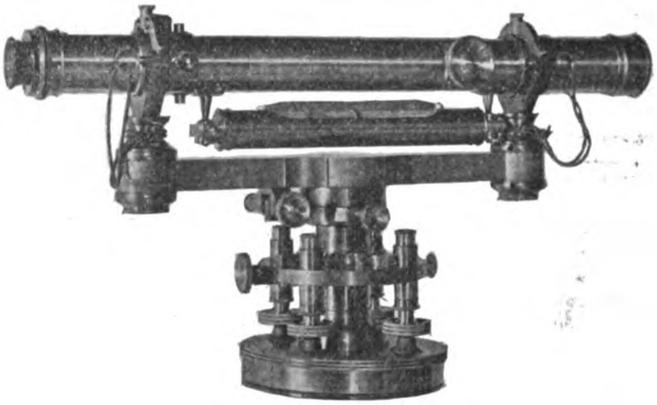
All parts accurately finished, bronzed to reduce reflection of light rays, and heavily lacquered; telescope optics, designed for high magnifying power, with plenty of light, and flat field, shows objects erect and sharply defined; stadia hairs can be moved in or out of the field of vision by micro-cross wires are focused by quick thread movement of eye piece.



Large Complete Combined Transit and Leveling Instrument With usual accessories, adjustable or fixed stadia, straight leg tripod. Price $220.00.

Graduations for transit spirit levels are made on glass; for tube of wye level, on strip of german silver over vial. All verniers, read to single minutes, gradutaed upon inlaid sheet silver.

All bearings and threads are of anti-friction metal; threads and slides are protected from dust and dampness.



18-Inch Engineers' Wye Level.
Complete with adjustable stadia and straight leg tripod.
Price $130.00.

SPECIFICATION AND PRICES—TRANSITS AND LEVELS.

	Large Transit Stock Instrument Regular $220 Complete with Tripod and Accessories	Intermediate $205 Complete	Small Mining and Reconnoissance Transit $198	18-in. Wye Level
Weight, Transit proper	12½ lbs.	8 lbs.	5½ lbs.	8 lbs.
Leveling Head (detachable) ...	3¾ lbs.	2 lbs.	2 lbs.	4 lbs.
Tripod, straight or split legs.......	6 lbs.	6 lbs.	6 lbs.	6¾ lbs.
Ready for use.....	23 lbs.	16 lbs.	13½ lbs.	18½ lbs.
Extension Tripod..	10 lbs.	7 lbs.	7¼ lbs.	7 lbs.
Eye Piece	Erecting	Erecting	Erecting	Erecting
Magnifying Power........	31 dia.	25 dia.	23 dia.	33 dia.
Diameter of Objective....	1¼ in.	15-16 in.	15-16 in.	1¼ in.
Length of Telescope (reversing	12 in.	9 in.	7½ in.	18 in.
Level of Telescope.......	7 in.	5 in.	4½ in.	8 in.
Diameter of Vertical Circle	5¼ in.	4½ in.	4½ in.	
Length of Needle.........	5 in.	3½ in.	3 in.	
Compass Ring Divided into	½°	½°	½°	
Compass Ring numbered: Inside row 0° to 90° in quadrants; outside ring continuous 0° to 360°.				
Diameter of Horizontal Graduated Plate.......	6½ in.	5¼ in.	4½ in.	

Horizontal Graduations are numbered with inside row or incline figures 0 to 360° continuous, outside row in quadrants 0 to 90°.

Above table covers features and specifications of our regular stock instruments, carried ready to ship within one to three days after receipt of order. Any special design, or figuring to graduations supplied.

PRICE-LIST OF EXTRA ATTACHMENTS.

Extension Tripod instead of regular straight round or split leg	$12.00
Half or Full Vertical Circle graduated upon silver, with double solid silver adjustable Vernier (minute reading), instead of 60° vertical arc..............	17.00
Aluminum Guard to full vertical circle	5.00
Disappearing Stadia Wires	5.00
Center in axis of Telescope for vertical plumbing......	3.00
Half minute (30 sec.) reading to horizontal plate	10.00
Twenty second reading to horizontal plate	15.00
Ten second reading to horizontal plate	20.00
Reflector, silvered for illuminating cross wires .... (removable)	4.00
Prism Eye Cap	9.50
Top-Telescope (detachable) for vertical sight, ... in shafts	35.00
Gradientor	7.00

Above prices to be added to cost of any regular stock Transit, irrespective of size.

THE C. F. PEASE COMPANY

221 Institute Place
CHICAGO, ILLS.

Largest Manufacturers of Blue Printing Machinery

Products

Pease Peerless Continuous Blue Printing Machines; Pease-Vertical Blue Printing Machines; Peerless Blue Print Washing and Drying Machines; Drawing Materials; Engineers' Transits and Levels; Field Supplies; Blue Print Papers and Cloths; Drawing, Detail and Tracing Papers; Profile and Cross-Section Papers.

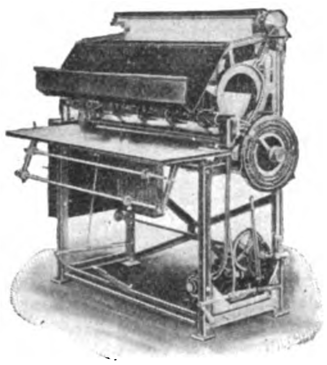
Try the Pease Gold Label Tracing Cloth and "Rigel" Tracing Paper. High in quality; Low in price.

We carry a stock of Berger's Transits and Levels, Chicago Steel Tapes and Leveling Rods, Field Books, etc.

ASK FOR CATALOG K AND SAMPLE BOOK OF PAPERS.

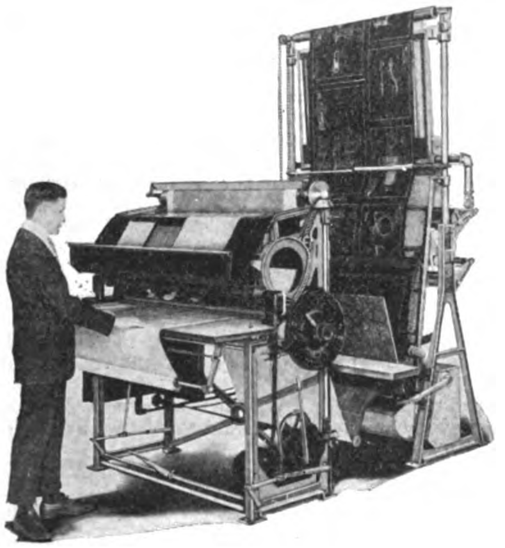
Pease Peerless Blue Printing Machine

Returns tracings direct to operator's hand. Very low in operating and maintenance expense. Noiseless. All speeds electrically controlled. Lamps independently connected, only necessary to turn on a sufficient number to cover width of paper being printed.



Peerless Blue Printing, Washing and Drying Machine

Prints, washes and dries on either paper or cloth, blue prints, blue line prints, negative or brown line prints by one continuous operation, any length in one piece and perfectly free from wrinkles or distortions. Positive black line prints may also be made on this machine. Shrinkage practically eliminated. Floor space for entire equipment only 5½ x 6½ feet. One operator does it all. Great economizer of time and labor. Write for further particulars.



Pease-Vertical Blue Printing Machine

(All-steel frame.)

Every machine carries the Pease guarantee for satisfaction and service. The most efficient and rapid Vertical Blue Print Machine made.

Shipped completely assembled; no danger of breakage. Made in five sizes.

Pease Sheet Washing and Drying Machine For Blue Prints

No wet floors. Can be placed against the wall; takes no more space than a radiator. Washes blue prints up to 42x72"; also blue line, negative and brown line prints.

ECONOMY DRAWING TABLE CO.

TOLEDO, OHIO

DESIGNERS AND MANUFACTURERS OF

Drawing Tables and Filing Cases Economy Dust Proof Filing Cases

Dust-Proof Sectional Filing Case.

This cut shows a two-section standard case with 4-inch deep drawer in base. Each section has six drawers. Spring cover will double the capacity of a drawer.

2 Five Drawer Sections No. 350 or No. 360.
1 Sanitary Base No. 358 or No. 368.

Dust Proof Sectional Filing Cases

A unique, compact and practical way of filing valuable drawings and protect them from dust and theft.

Standard sizes are made in sections of 7-drawers 26x38x1½" and 32x44x1½" deep. The sides and back of sections are paneled. The rear end of drawers have a hood to prevent drawings working over the rear ends. The front cover or sliding door is hinged to a sliding frame and the door swings similar to the well known sectional Book Cases. The door can be fitted with lock. Other sizes made to order.

When writing for estimates please give full particulars.

DUST PROOF FILING CASE SECTIONS 32"x44"

No.	Standard Case	Code	Weight
240	Loose Cap	Pohew	50 lbs.
241	Plain Base	Ponad	35 "
242	Base 4" Drawer	Poimus	90 "
244	Section of 7 Drawers 1½" deep, 32x44"	Polobad	200 "

DUST PROOF FILING CASE SECTIONS 26"x38"

No.	Standard Case	Code	Weight
245	Loose Cap	Podos	35 lbs.
246	Plain Base	Pofut	30 "
247	Base 4" Drawer	Porig	70 "
248	Section of 7 Drawer 1½" deep, 26x38"	Powemly	175 "

STANDARD SECTIONAL FILING CASES 32"x44"

No.	Standard Case	Code	Weight
200	Loose Caps	Pavda	50 lbs.
201	Section of 1 Drawer 4" deep, 32x44	Paxpe	80 "
204	Section of 4 Drawers 3 5/16" deep	Palso	80 "
206	Section of 6 Drawers 2" deep, 32x44	Pagmuch	160 "
208	Pine Drawing Board Top	Paced	45 "
210	Plain Base	Papri	30 "
212	Section of 4" deep, ½ size, 32x21	Papwe	80 "
214	Base with 4" Drawer	Pahua	80 "
218	Sanitary Base 8" high	Paweb	40 "

SECTIONAL FILING CASES 26"x38"

No.	Standard Case	Code	Weight
220	Loose Cap	Pedan	30 lbs.
221	Section 1 Drawer 4" deep, 26x38	Peper	60 "
224	Section of 4 Drawers 3 5/16" deep, 26x38	Pelos	125 "
226	Section of 6 Drawers 2" deep, 26x38	Pebort	125 "
228	Pine Drawing Board Top	Pecla	30 "
230	Plain Base	Pekte	60 "
232	Section of 2 Drawers 4" deep, ½ size, 26x18¾	Pepik	60 "
234	Base with 4" Drawer	Pench	60 "
238	Sanitary Base 8" high	Pelup	30 "

The sectional filing case is designed with loose cap and base.

The base will be furnished with a 4-inch deep drawer, as shown in cut, plain base without drawer or 8-inch sanitary base.

Drawers 3 5/16 inches deep should be used for filing blue prints or drawings that do not pack close together, and drawers 2 inches deep for tracings. The drawers have a six-inch lid at the top and back to protect drawings. The sectional case enables one to build up the filing cases as requirements demand, and to fill in odd spaces.

The sections are put together without screws or fastenings, but are held in all directions, and are interchangeable.

Steel Sectional Filing Case

To offset the high cost of steel we have evolved a new type of construction which reduces the manufacturing cost and enables us to sell **Economy Steel Drawing Tables** and **Filing Cases** at prices much lower than the prevailing prices of Steel Furniture. This construction detracts in no way from the usefulness, durability and handsome appearance of the furniture. All joints are electrically welded and each article is sold under our positive guarantee: "that if goods are not satsfactory and as represented, they may be returned at our expense and money refunded." Although our wood filing cases and drawing tables are as good as is possible to make them, there are some advantages in steel furniture on account of the natural qualities of steel.

Lessen your chances of fire and increase the general safety by making your office and drafting room fire proof. Steel furniture never grows old, is fire resisting, and weather proof and the drawers will not be affected by atmospheric conditions.

How Economy Steel Furniture is Built

Strength of design, utility and durability are combined in each piece of **Economy** furniture.

The steel is carefully selected from the choicest cold rolled, re-annealed, pickled patented, leveled open hearth stock known as Automobile body stock or metal furniture stock.

Our filing cases and tables are made by skilled workmen on special machinery and dies, so that every part is interchangeable with like parts.

No.	SPECIFICATIONS Standard Case	Code Word	Weight Crated
350	Section 5 Drawers, 26"x38"x2"	Ufele	200 lbs.
358	Sanitary Base	Ubgen	35 "
355	Plain Base	Uboer	30 "
360	Section 5 Drawers, 32"x44"x2"	Ubuap	235 "
368	Sanitary Base	Ubfal	35 "
365	Plain Base	Ubard	30 "

EXTRAS

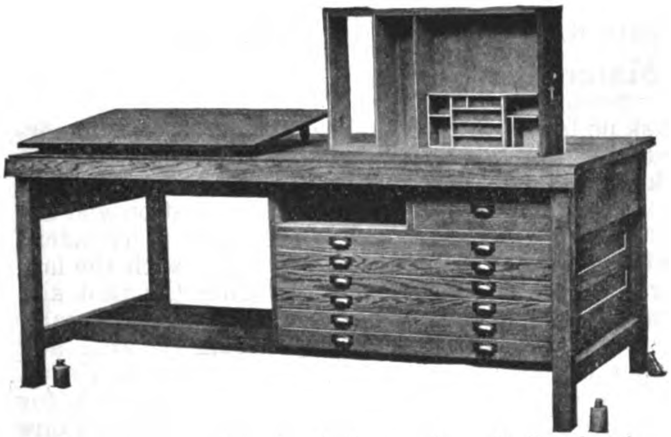
Drawers divided in center making two compartments.

Drawers divided, making four compartments.

Holding-Down-Wires, must be ordered as extras.

In stock for prompt shipment.

Economy Drawing Tables Made in Wood and Steel



Styles No. 0, 1 and 2 in wood, showing loose incline drawing board and drawers with sliding tool tray.
Styles Nos. 50, 51 and 52 in steel.

No. 0—Top soft pine 39x84x1⅜"—table 34 inches high—two small drawers 21x24x5¼ inches inside; in two compartments 18x21" and 6x21". Six large drawers 32x44x2" with six-inch lid on back of drawer to prevent drawings slipping out—with paneled back and sides—set of 4-rising blocks to adjust height of table.

Material oak, except top; finish 3-coat dull rubbed smooth. Tables finished antique oak, unless specified otherwise; code word, Hapway.

No. 1—Specifications same as No. 0; top 39x84x1⅜"; two small drawers 18x24x5¼" with two compartments 18x18" and 6x18"; six large drawers 26x38x2"; code word, Hepride.

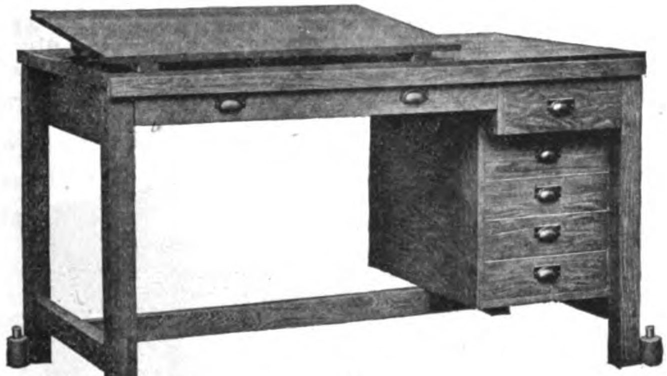
No. 2—Specifications same as No. 0; top 34x72x1⅜" two small drawers 18x24x5¼"; six large drawers 26x38x2"; code word, Hoper. Other sizes made to order.

Steel Drawing Tables

No. 50—Drawing and Reference Table and Filing Case Combined. Top soft pine, 39x84x1⅜". Table 35 inches high. Two small drawers 21x24x4" inside; compartments 18x21" and 6x21". Six large drawers 32x44x2" inside. These drawers have a lid at the top and back to prevent drawings from slipping out. Set of four rising blocks to adjust height of table; code word, Tuband.

No. 51—Top 39x84". Height 35 inches. Two drawers 18x24x4" inside. Six drawers 26x38x2" inside; code word, Tupele.

No. 52—Top 34x72". Height 35 inches. Two drawers 18x21x4" inside. Six drawers 26x38x2" inside; code word, Turnip.

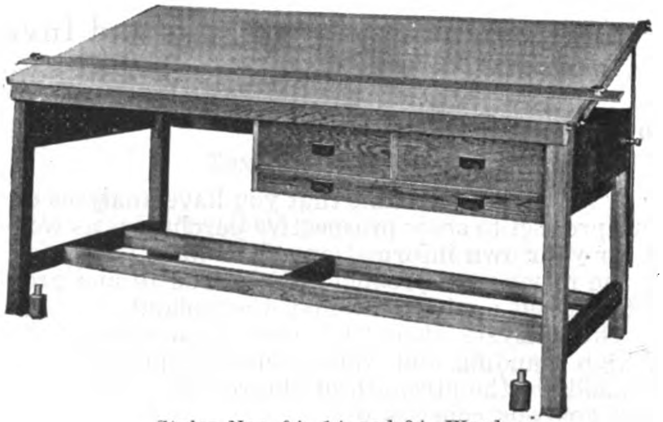


Style No. 4.

Style No. 4—Top, 33x60"; 1 drawer 13x26x4"; 4 drawers 13¾x24¼x3¾", and 1 drawer 26x38x2¼".

Style No. 3—Top 33x60"; 1 drawer 13x26x4", and 1 drawer 26x38x2¼".

Standard Tables are 34 inches high.
Raising Blocks 1, 2 or 3 inches high.



Styles Nos. 0A, 1A and 2A, Wood.
Showing adjustable top and parallel rule attachment.
Styles 50A, 51A and 52A in steel.

No. 0A—Top soft pine 39x84x1⅜"; table 34 inches high; two small drawers 21x24x5¼" inside; in two compartments 18x21 and 6x21 inches; one large drawer 32x44x2"; set of 4 raising blocks. Material oak, except top; finish three coat dull rubbed smooth; code word, Harwide.

No. 1A—Specification same as 0A; top 39x84x1⅜"; two small drawers 18x24x5¼"; one large drawer 26x38x2"; code word, Hedric.

No. 2A—Specifications same as 0A; top 34x72x1⅜"; two small drawers 18x24x5¼"; one large drawer 18x38x2"; code word, Hodan. Other sizes made to order.

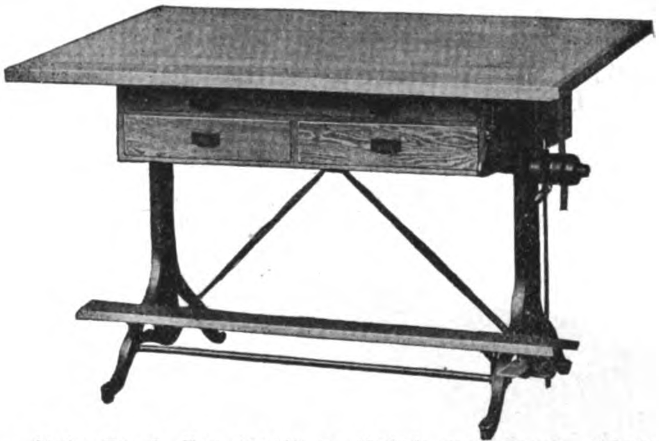
Steel Drawing Tables

No. 50A—Steel drawing Table. Top soft pine, 39x84x1⅜"; table 35 inches high; two small drawers 21x24x4" inside, in two compartments 18x21" and 6x21"; one large drawer 32x41x2" inside. Set of four raising blocks to adjust height of table; code word, Targe.

No. 51A—Top 39x84"; height 35 inches; two drawers 18x24x4"; one drawer 26x38x2"; code word, Tempe.

No. 52A—Top 34x72"; height 35 inches; two drawers 18x24x4" inside; one drawer 26x38x2" inside; code word, Tipad.

Note—The "A" type of tables can be converted into a combination drawing table and filing case by adding a standard five drawer section.



Style No. 6—Top 37x48" to 42x84"; as ordered. Height 32" to 48". Cabinet contains: 2 drawers 18x24x4" and 1 drawer 26x38x2".

Style No. 5—Same as No. 6, without cabinet.
We also make a single-pedestal design, for smaller tops.

Iron Base Adjustable Table

This table can be readily adjusted from the sitting position either for inclination or height.

The foot lever raises table top to desired height. The hand screw adjusts inclination and the hand lever lowers top.

Facilities

We operate the largest Drawing Room furniture factory in the United States, and carry a large variety of styles for immediate shipment. All work is of the highest grade.

Economy Tables and Cases are used by the leading manufacturers, the Government, State, County and City Departments throughout the country. Also by the leading schools and colleges.

If interested in "Economy", we will be pleased to favor you with illustrated catalogue and Price List upon application.

The Metallurgical Laboratory

613 BAILEY FARRELL BLDG., PITTSBURGH, PA.

(Established 1901)

Make Analyses, Tests and Investigations of All Kinds of Known or Unknown Materials

To the Producer of Coal:

What Does Your Coal Analyze?

It is highly important that you have analyses of your product to show prospective purchasers as well as for your own information. You want credit for all the merit your product entitles you to and protect yourself against unfounded complaints.

The analyses should be made by a Laboratory of high standing and widely known reputation, as this adds to the strength of the results. The ordinary analysis consists of

Moisture,
Volatile Matter,
Fixed Carbon,
Ash,
Sulphur
Phosphorus.

In addition to these we also determine the BRITISH THERMAL UNITS (B. T. U.) and the Fusing Point of the Ash. Knowledge of this Fusing Point enables the user to understand the Clinkering or Non-clinkering qualities of the coal. This is a new and highly important test.

We make mineral analyses of Water to determine its suitability for Boiler use, and furnish information for correction when necessary. We also make sanitary analyses and bacteriological examinations to determine fitness for drinking.

To the Consumer of Coal:

What is the Analysis of the Coal You Are Using?

The consumer should be even more concerned as to the quality of the Coal being used than the producer. Our booklet, "Uncle Walt Mason's Remarks" on coal will add force to this declaration. Ask us for a copy. It is free. It shows in a humorous, but highly pertinent manner, the necessity for "knowing".

We are specialists in fuel determination and are continually "checking" with the chief independent laboratories of the country, as well as with the laboratories of the consumers. During the past sixteen (16) years we have made thousands of analyses on the coals and cokes of Pennsylvania and other coal fields. We make inspections and samplings of coal and coke at points of production for both foreign and domestic shipments; also, umpire samplings for adjustment of controversies; consultation, investigation and advice as to the best and cheapest coal for consumers' requirements.

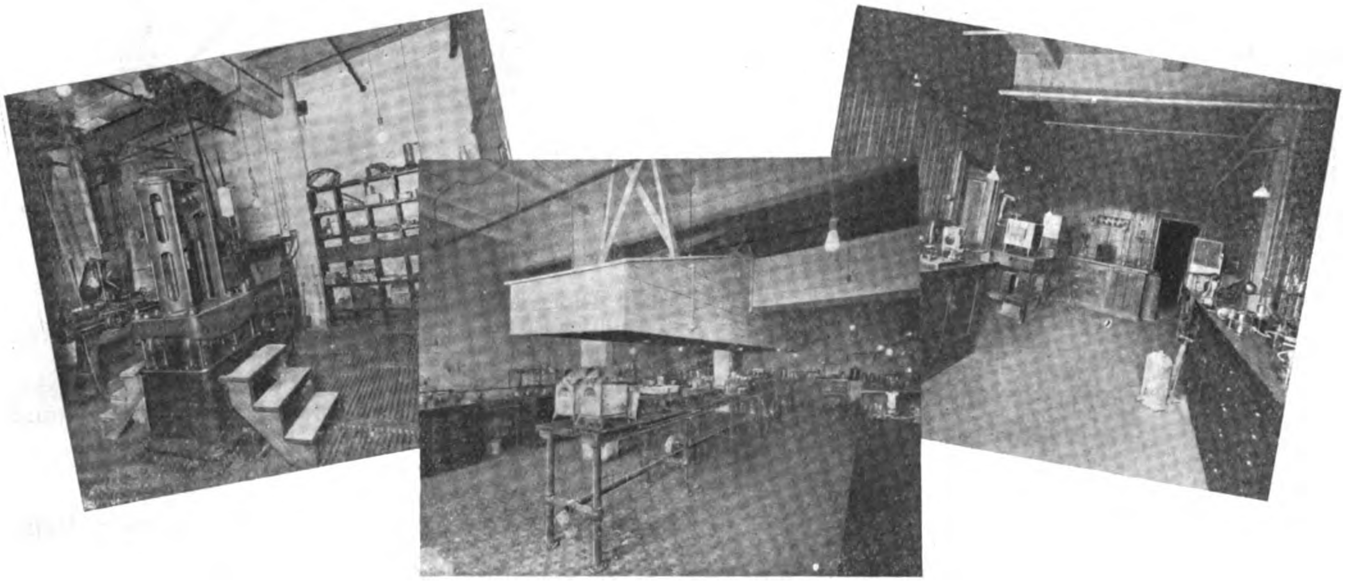
Special Service

Examination of undeveloped coal lands, developed, operating or idle mines, giving geological and economical reports with detailed descriptions, photographs, maps, etc., etc., with investigations and samplings of coal, recoverable tonnage, economical production, proper preparation, best uses of product and proper selling markets. Mine samplings for improvement of product, either as coal or for coke. Coke yield, ash and phosphorus content and sulphur elimination determined in terms of coke from coal.

Research and General Analyses

In our research department we are prepared to investigate any problems. We analyze Fire Clay, Brick, Cement, Limestone, Sand, Mine Gas, Natural Gas, Gasoline content of natural gas, Oils, Paint, Iron, Steel, Brass, Bronze, Babbitt, Alloys, Drosses, Ores of Iron, Manganese, Copper, Tungsten, Molybdenum, Chrome, Titanium, Gold, Silver, etc., etc.

We specialize in Glass analyses and in the materials used in its manufacture.



Views of Our Laboratory at Pittsburgh, Pa., Showing Completeness of Equipment.

RANDOLPH-MEANS COMPANY

Oliver Building, Pittsburgh, Pa

Consulting Electrical Engineers

Efficiency, the key-note of progression, as applied to the modern industry, is defined as the facility with which one handles the tools of his profession, and is at a maximum when data and materials are in such form as to secure the desired results with a minimum expenditure of time, money and physical or mental effort. Efficiency may reach a high degres of perfection through the channels of inventive ingenuity, or it may be greatly increased by the standardization of devices and methods, but, no matter how attained, it invariably never brings about results worthy of admiration unless it represents an abundance of keen, sound judgment evolved from the dictations of past experience.

In the past, the relatively small cost of power in connection with the production of coal, has allowed the item of efficient generation and use of power, to be considered as a superfluous factor, and possibly this precdnent would reach far into the future were it not for the present urgent demand for increased production.

This demand, although of such proportions that it may be inadequately met, must necessarily be dependent, to a very large extent, upon the existing mines, for relief; therefore, if the supply of coal is to be at all in proportion to the demand, and is to reach a result worthy of merit, it must be brought about by the utmost efficiency in the use of existing and available equipment, and by employing only those methods which make failure and excessive waste impossible.

Manifestly there are almost as many methods of performing a certain work as there are types of people. Each method may bring about the desired result, but the manner in which the result is accomplished will vary greatly in efficiency. There is only one best method for a given set of conditions. Nor will this best method always remain the same. Standards permit satisfactory results within their scope, but they so often tend to crystallize error. The ever changing conditions brought about by extending the operations and by revising certain methods, present a continuous round of problems, upon the correct solution of which, is dependent the success or failure of the entire proposition. Many instances constantly appear whereby increased efficiency is not a matter of investment. It is not a matter of installing elaborate equipment. It is a matter of highly specialized knowledge and unlimited investigation of the requirements in every phase.

If one labors without intelligence he is simply trudging a tread-mill and the energies which could have been potent for effectiveness are dwarfed by compulsory exertion of uninteresting, unproductive effort. The progressive coal producer realizes that an inevitable re-adjustment is at hand, and he is making preparations to provide for the emergency when it arises. Nor is he making these preparations unguided. He is sealing the self-preservation of his industry by co-operating with specialized experience.

Increased efficiency and co-operation are the needs of our day.

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

TIPPLE SECTION
PREPRATION & LOADING OF COAL

Engineering Data

Inquiry data for Perforated Metal.
Inquiry data for Crushers.
Inquiry data for Scales.
Comparative Gauges Steel Sheets and Plates.
Capacity and Speed Chart of Belt Conveyors.
Capacity and Speed Chart of Bucket Elevators
Capacity of Spiral or Screw Conveyors.
Horse Power of Driving Chains.
Horse Power Chart of Belt Conveyors.

The following manufacturers have catalogue descriptions in this section:

Allen & Garcia Co.
Cross Engineering Co.
Dempcy-Degener Co.
Dodge Sales & Engineering Co.
Elmore, G. H.
Fairbanks Co., The
Fairmont Mining Machinery Co.
General Electric Co.
Goodrich, B. F. Co.
Hendricks Mfg. Co.
Heyl & Patterson, Inc.
International Conveyor Corp.
Jacobson & Schraeder, Inc.
Jeffrey Mfg. Co.
Kanawha Manufacturing Co.
Krehbiel Company.
K-B Pulverizer Co., Inc.
Link-Belt Co.
Main Belting Co.
Malcolmson Briquet Engineering Co.
Manierre Engineering & Machinery Co.
Marion Machine Fdy. & Supply Co.
Mashek Engineering Co.
Morrow Manufacturing Co., The
Ottumwa Box Car Loader Co.
Pennsylvania Crusher Co.
Phillips Mine & Mill Supply Co.
Pittsburgh Coal Washer Co.
Remaly Manufacturing Co.
Roberts & Schaefer Co.
Robins Conveying Belt Co.
Standard Scale & Supply Co.
Stedman's Foundry & Machine Works.
Stephens-Adamson Mfg. Co.
Streeter-Amet Weighing & Recording Co.
Tamaqua Mfg. Co.
Webster Mfg. Co.
Westinghouse Elec. & Mfg. Co.
Williams Patent Crusher & Pulverizer Co.
Wilmot Engineering Co.
Winslow Government Standard Scale Works.
Wisconsin Bridge & Iron Co.
Wood Equipment Co.

For additional descriptions of Tipple Equipment, not appearing in this section, refer to Index of Products in front of book.

Inquiry Data for Perforated Metal.

Mention the number of sheets and the kind of metal desired.

Also the size of sheets—both length and width—in inches.

If an irregular size is wanted, send a rough sketch showing shape of sheets, and on each side note dimensions.

Either send a sample, showing the exact thickness of the metal wanted, or note same by United States Standard, Brown & Sharpe's, (American) or Birmingham (English) standard gauges, of which tables are appended.

If any blanks or plain margins are wanted, mention this, and note plainly on what part of the sheet they should be.

Mention the shape and size of the perforations desired. If slotted holes, state which way of the sheet of metal you wish the perforations to run.

It is always advisable to send a rough sketch, showing the size and the shape of the sheets, the size and shape of the perforations, and which way of the sheet they run—unless they are round or square.

If designed for cylinder screens, state whether butt or lap joints are required and whether the inside or outside diameter of the screen is given.

COMPARISON OF GAUGES FOR STEEL SHEETS AND PLATES

APPROXIMATE THICKNESS IN INCHES, AND WEIGHT PER SQUARE FOOT IN POUNDS

U. S. STANDARD GAUGE				BIRMINGHAM GAUGE		AMERICAN GAUGE (B. & S.)	
No. of Gauge	Fractions	Decimals	Weight	Decimals	Weight	Decimals	Weight
000	3-8	.375	15.30	.425	17.28	.409	16.71
00	11-32	.343	14.025	.38	15.45	.364	14.88
0	5-16	.312	12.75	.34	13.82	.324	13.26
1	9-32	.281	11.475	.30	12.20	.289	11.80
2	17-64	.265	10.8375	.284	11.55	.257	10.51
3	1-4	.25	10.2	.259	10.53	.229	9.36
4	15-64	.234	9.5625	.238	9.68	.204	8.34
5	7-32	.218	8.925	.22	8.95	.181	7.42
6	13-64	.203	8.2875	.203	8.25	.162	6.61
7	3-16	.187	7.65	.18	7.32	.144	5.89
8	11-64	.171	7.0125	.165	6.71	.128	5.24
9	5-32	.156	6.375	.148	6.02	.114	4.67
10	9-64	.140	5.7375	.134	5.45	.101	4.16
11	1-8	.125	5.1	.12	4.88	.09	3.70
12	7-64	.109	4.4625	.109	4.43	.08	3.30
13	3-32	.093	3.825	.095	3.86	.072	2.94
14	5-64	.078	3.1875	.083	3.37	.064	2.62
15	9-128	.070	2.86875	.072	2.93	.057	2.33
16	1-16	.062	2.55	.065	2.64	.05	2.07
17	9-160	.056	2.295	.058	2.36	.045	1.85
18	1-20	.05	2.04	.049	1.99	.04	1.64
19	7-160	.043	1.785	.042	1.71	.035	1.46
20	3-80	.037	1.53	.035	1.42	.032	1.31
21	11-320	.034	1.4025	.032	1.30	.028	1.16
22	1-32	.031	1.275	.028	1.14	.025	1.03
23	9-320	.028	1.1475	.025	1.02	.022	.922
24	1-40	.025	1.02	.022	.895	.020	.82
25	7-320	.021	.8925	.02	.813	.017	.73
26	3-160	.018	.765	.018	.732	.015	.649
27	11-640	.017	.70125	.016	.651	.014	.579
28	1-64	.015	.6375	.014	.569	.012	.514
29	9-640	.014	.57375	.013	......	.011	.461
30	1-80	.012	.51	.012	......	.01	.408

¶ Sheet mills roll steel sheets to U. S. Standard gauge unless otherwise ordered. Plate mills usually roll heavy plates 3-16 and heavier, and light plates No. 8 to No. 12 to Birmingham gauge.

¶ In figuring weights of Steel Plates add to above the allowances for over-weight, adopted by Association American Steel manufacturers.

¶ Brass is rolled to thickness by Brown & Sharpe's American Gauge.

¶ Copper is rolled to thickness by Stubs' or Birmingham Gauge.

Courtesy of Hendrick Mfg. Co.

Inquiry Blank for Crushers.

What material do you wish to crush? ....

What is the size of the material before crushing?... ....

If Coal, from what seam does it come? ....

If Coal, is it R. O. M. or sized? ....

What size finished product is wanted?...........

What capacity, in tons per hour, do you wish to handle? ....

Is the material damp or dry? ....

What percentage of moisture does it contain? ......

For what purpose is the finished product wanted?.. ....

Inquiry Data for Scales.

Style of Scale:
Railroad Track ....
Wagon ....
Hopper ....
Tipple ....
Portable ....

Style of Beam:
Single with Weights......................
Double with Weights ....
Tripple with Weights ....
Compound ....
Recording ....

Distance from middle of edge of platform to beam rod ....

Capacity:
Total—Dead and Live Load ....
Dead Rail ....

Platform:
Length ....
Width ....

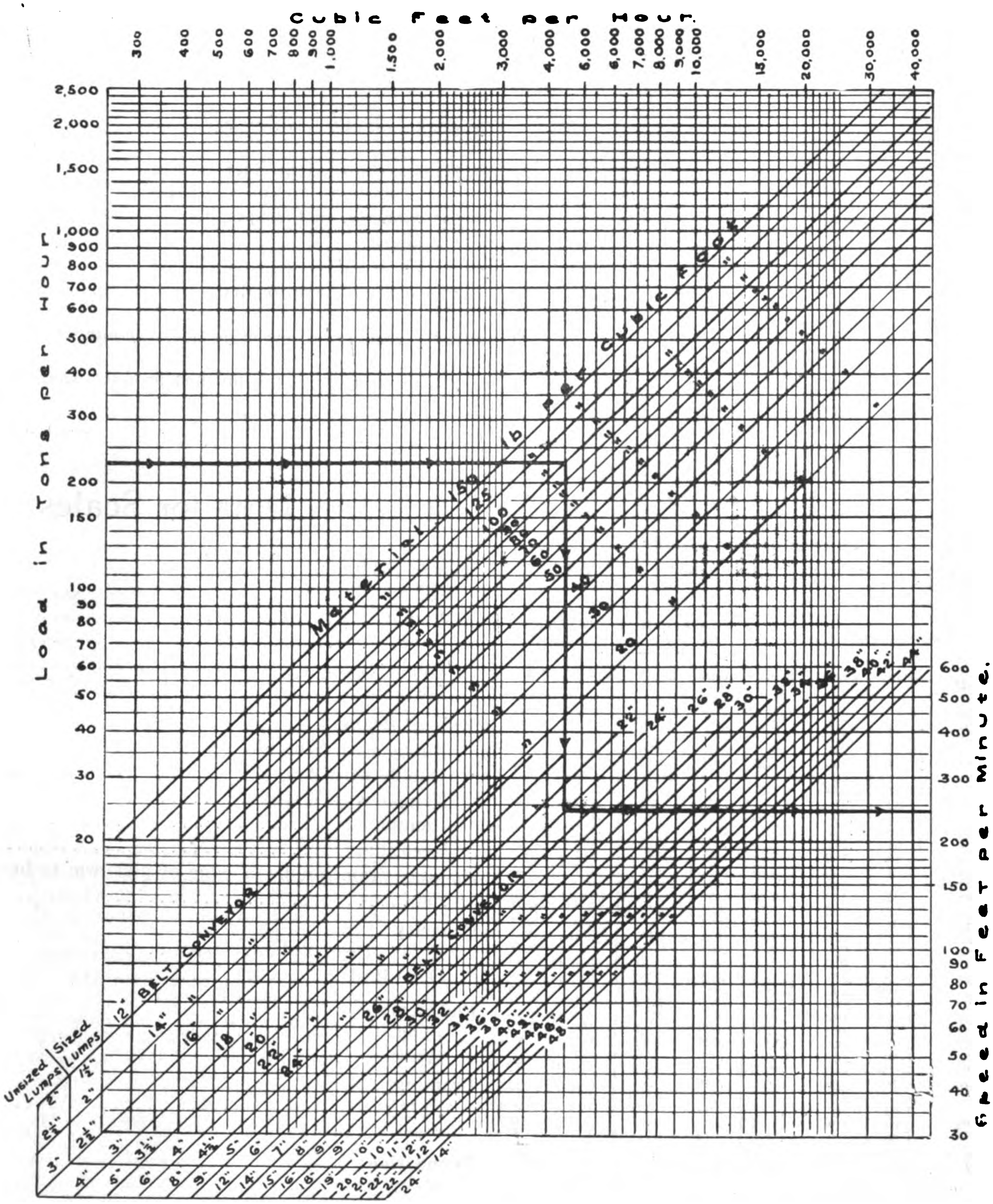
Framing:
Timber ....
Steel ....

Foundation:
Stone ....
Concrete ....

Character of soil where scale will be erected...... ....

Number of feet of straight track where scale will be located ....

Capacity and Speed Chart of Belt Conveyors

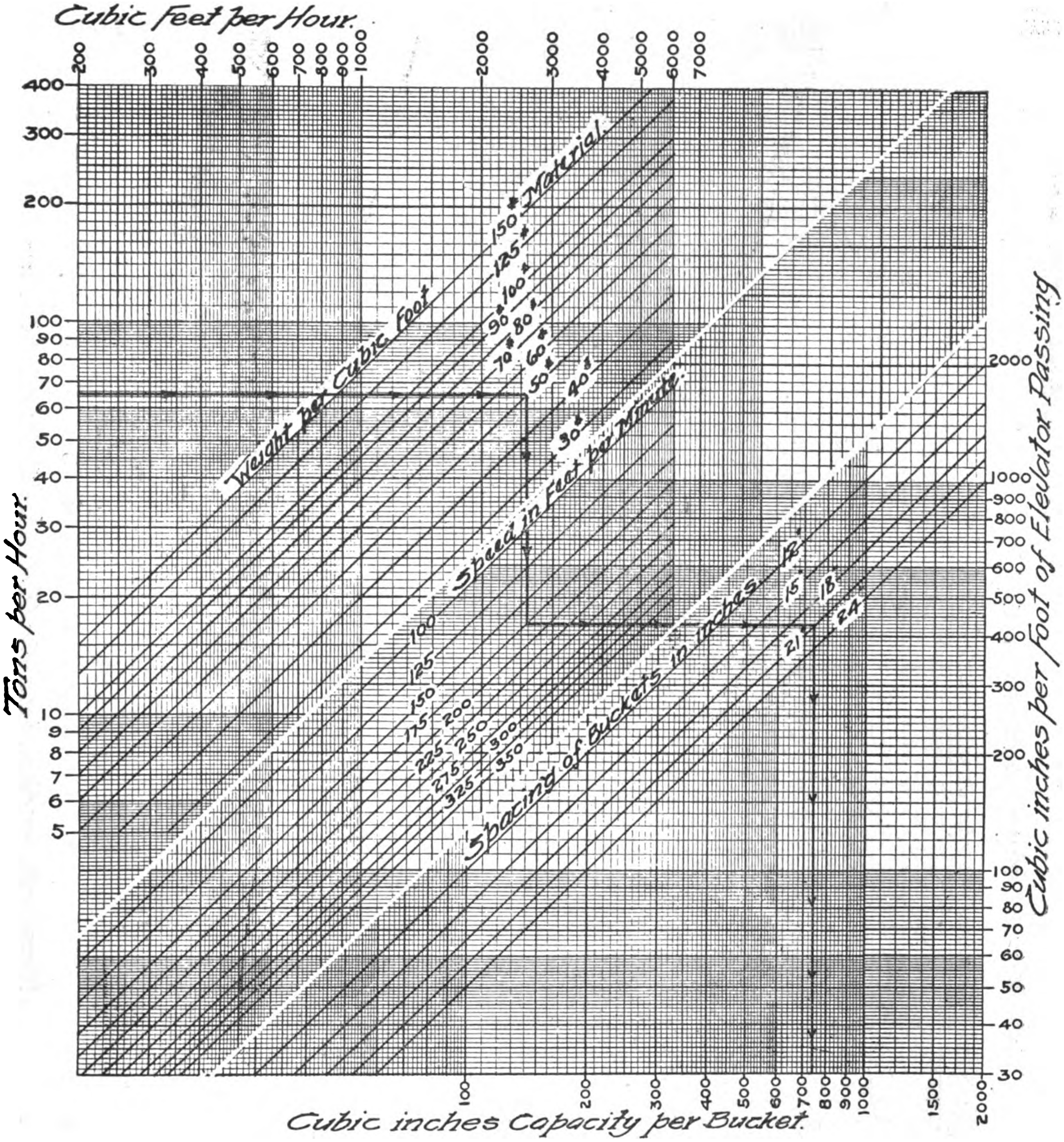


TO FIND THE WIDTH AND SPEED OF BELT TO MOVE DESIGNED TONNAGE OF GIVEN SIZE OR WEIGHT OF ORE, FOLLOW HORIZONTAL LINE OF THE GIVEN TONNAGE TO INTERSECTION WITH ONE OF THE UPPER SET OF DIAGONALS, THEN FOLLOW THE VERTICAL DOWNWARD TO INTERSECTION OF SECOND SET OF DIAGONALS CORRESPONDING TO ANY DESIRED WIDTH OF BELT, THEN FOLLOW OUT HORIZONTALLY TO THE SPEED SCALE, WHICH GIVES SPEED FOR THE BELT.

Courtesy Robins Conveying Belt Co

Capacity and Speed Chart of Bucket Elevators

Courtesy Robins Conveying Belt Co.



To find the proper size of a Bucket Elevator for a given tonnage or volume of material per hour and given weight per cubic foot:

Enter chart at left with tons per hour and follow across to diagonal line showing weight per cubic foot, thence down to diagonal line representing the desired speed of elevator, thence across to the right until the diagonal showing desired spacing of buckets is reached. At the bottom, directly below this intersection, is found the required capacity of buckets in cubic inches.

If the hourly capacity is given in cubic feet, enter at the top of the chart and follow down until the desired speed line is found, thence across to spacing, etc., as before.

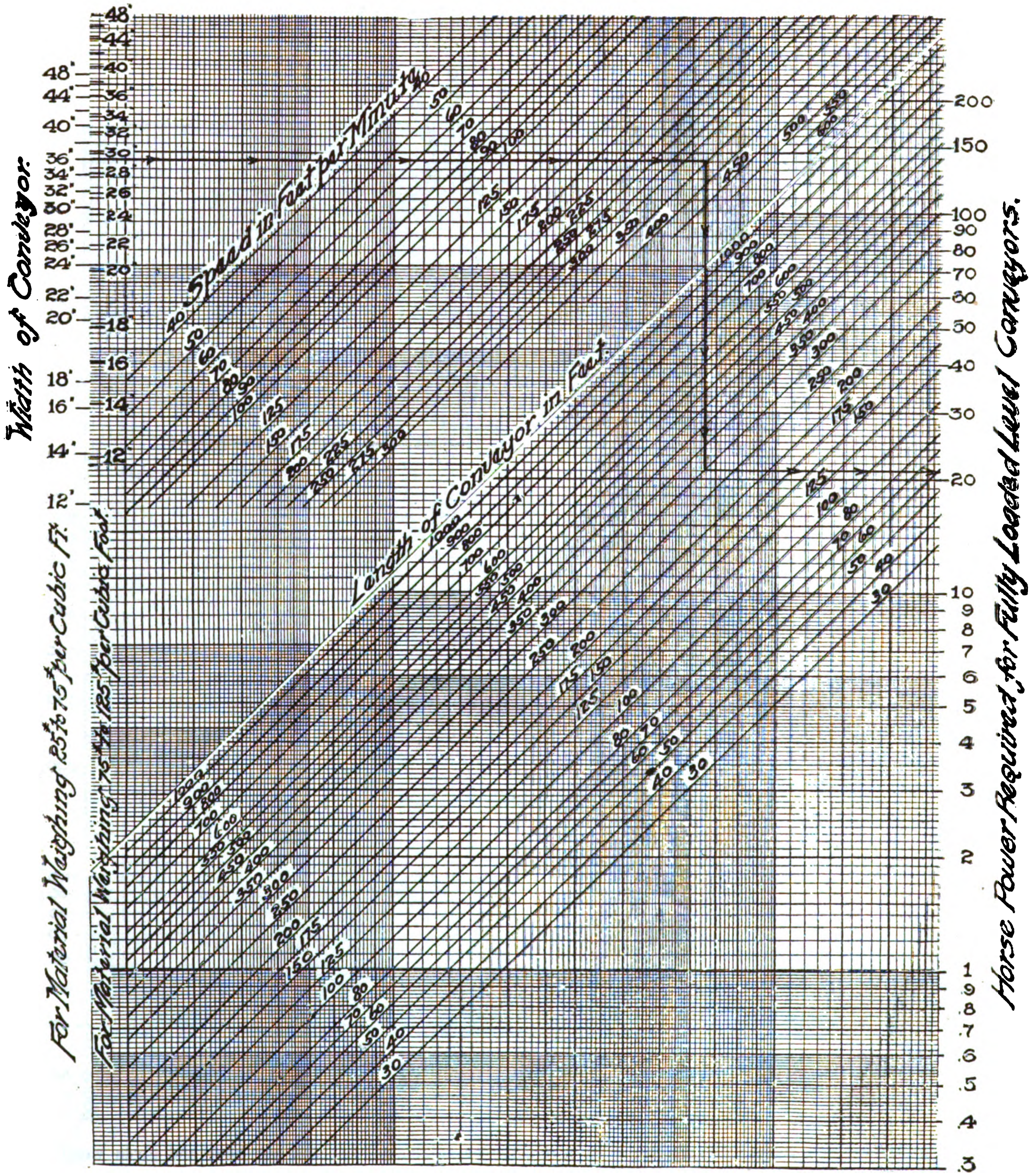
It should be borne in mind that the required bucket capacity found in the diagram is the working capacity, and somewhat larger buckets should be used, depending on conditions. It is common practice to assume the working capacities of Salem Buckets as two-thirds to three-quarters of total capacity when elevators are vertical.

The heavy line gives the solution for 65 tons of coal per hour at a speed of 175 feet per minute and a spacing of 21 inches, showing required working capacity of bucket of 740 cubic inches.

Horsepower required—To find horsepower required for driving a vertical bucket elevator multiply tons per hour by lift in feet and divide by 500. This allows for 100 per cent friction.

Horse Power Chart for Belt Conveyors

Courtesy Robins Conveying Belt Co.



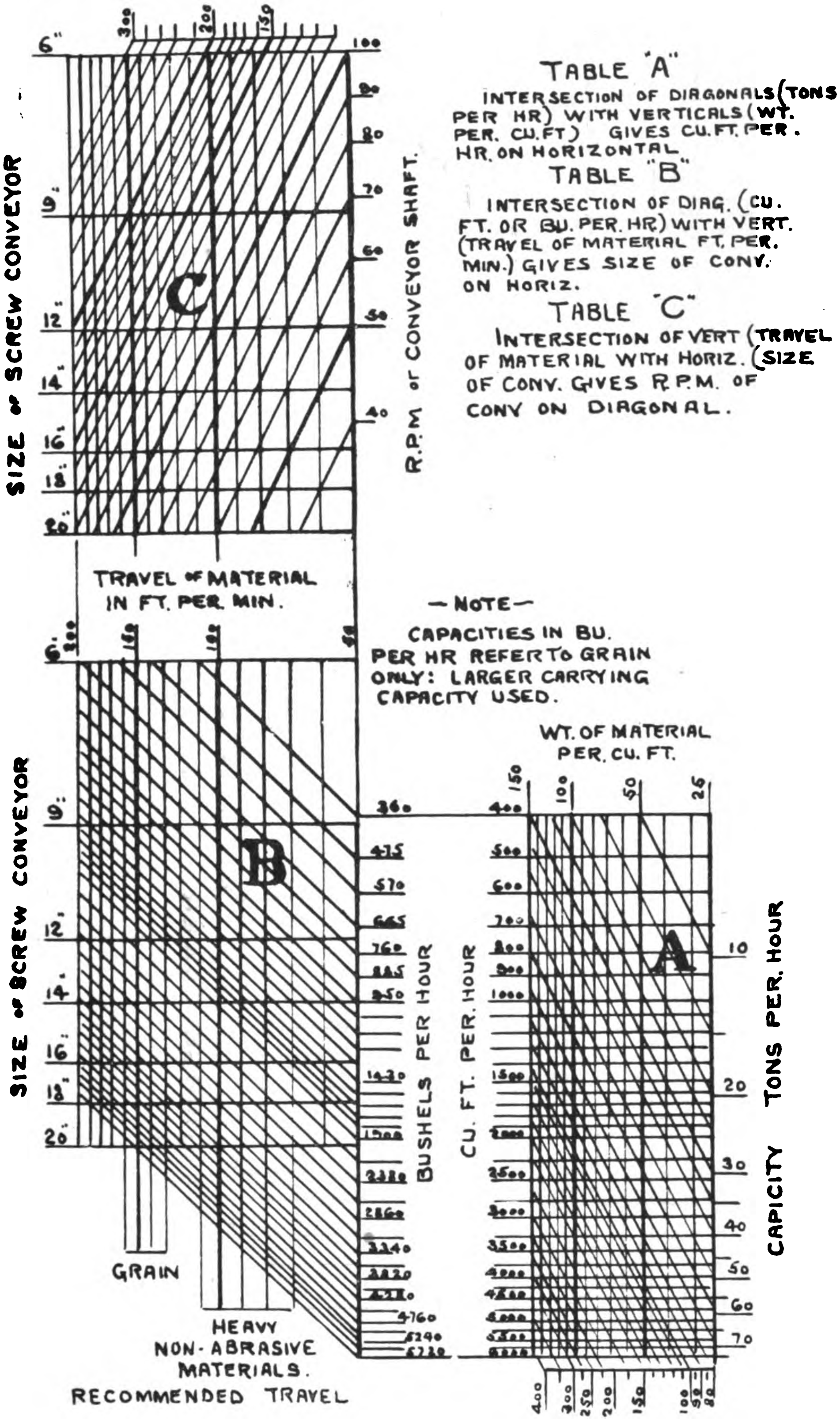
To find the Horse Power required by a fully loaded horizontal Belt Conveyor:

Select the proper width and speed of the conveyor from the chart. Enter the Horse Power Chart at the left margin, being careful to use the "width" column corresponding to light or heavy material as the case may be. From the width follow horizontally across to the diagonal giving speed of belt in feet per minute, thence down to the diagonal giving length of conveyor, thence across to the right margin where the required horsepower will be found. It is obvious that a conveyor designed to carry less than full load, will require less horsepower than indicated by the chart, but as a precaution against the possible use of a full load, we recommend that the full-load horse power be used.

The heavy line indicates the solution for a level, fully loaded, 36 inch conveyor 300 feet long, carrying material weighing not over 75 lbs. per cu. ft. at a speed of 350 feet per minute, and shown that 21 HP. will be required.

For inclined Conveyors, add one one-thousandth part of a horsepower for each foot-ton of lift per hour.

Capacity of Spiral or Screw Conveyors.



Use of Diagram

For example: Find size and speed of spiral conveyor for 40 tons of anthracite per hour. Anthracite weighs 55 lbs. per cu. ft. Starting at the right side of Section A of the diagram and following the diagonal for 40 (tons per hour) to the vertical for 55 (pounds per cubic foot), and thence horizontally to the left we read 1,500 cu. ft. per hour. Crossing to section B and following the diagonal upward into the range of travel speeds recommended for heavy non-abrasive materials, we have the choice between using a 12-in. conveyor with a travel speed of 75 ft. per minute. Here lies the opportunity for application of experienced judgment. We will use the 14-in. conveyor and the easy travel speed of 80 ft. per minute. Following the vertical for this 80-ft. travel speed up to Section C of the diagram we find, at the horizontal for 14-in. conveyor, that the necessary rotative speed is just under the diagonal for 70 r. p. m. The 12-in. conveyor at 105 ft. per minute travel-speed would require a rotative speed of 105 r. p. m. In the lower rotative speed for the larger conveyor we find compensation for its extra size and cost.

The nature of the material, the sizes of its lumps, if any, the inclination of the conveyor box, and other modifying conditions must all be given consideration in application of the diagram results to actual practice.

Horsepower—C W L plus 33,000. C equals a constant: 0.65 for coal and .0 for heavier and sticky materials. W equals weight of material in pounds per hour. L equals length of conveyor in feet.

Courtesy Robins Conveying Belt Co.

Horse Power of Driving Chains

(Webster Mfg. Co.)

Upper diagram determines speed of chain for given diameter of sprocket wheel and revolutions per minute.

Intersection of horizontal lines (dia. of sprockets) gives speed of chain on diagonal line at that point.

Lower diagram determines horse power for chain.

Intersection of vertical lines (speed) and horizontal lines (size of chain) gives horse power on diagonal line at that point.

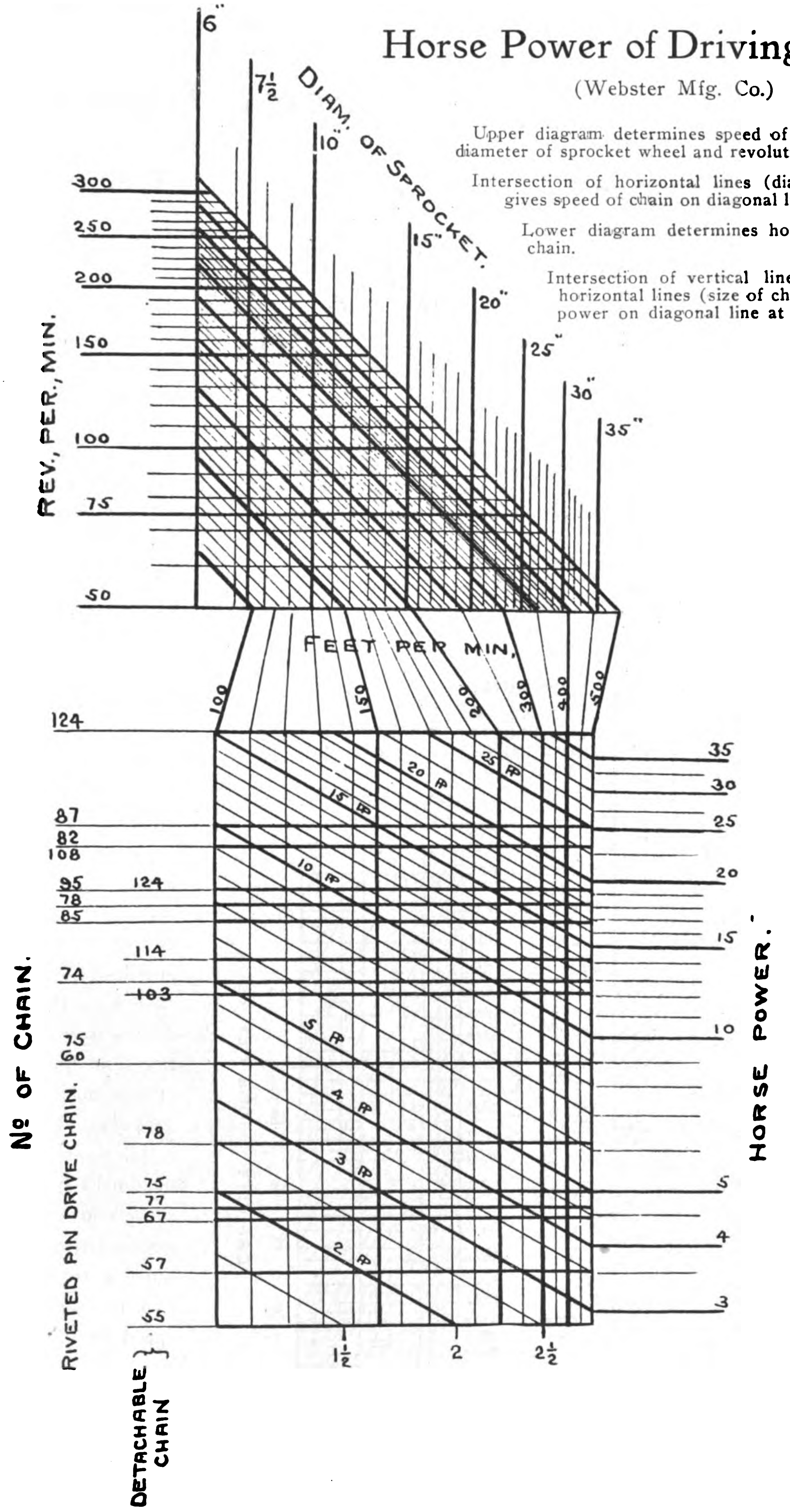
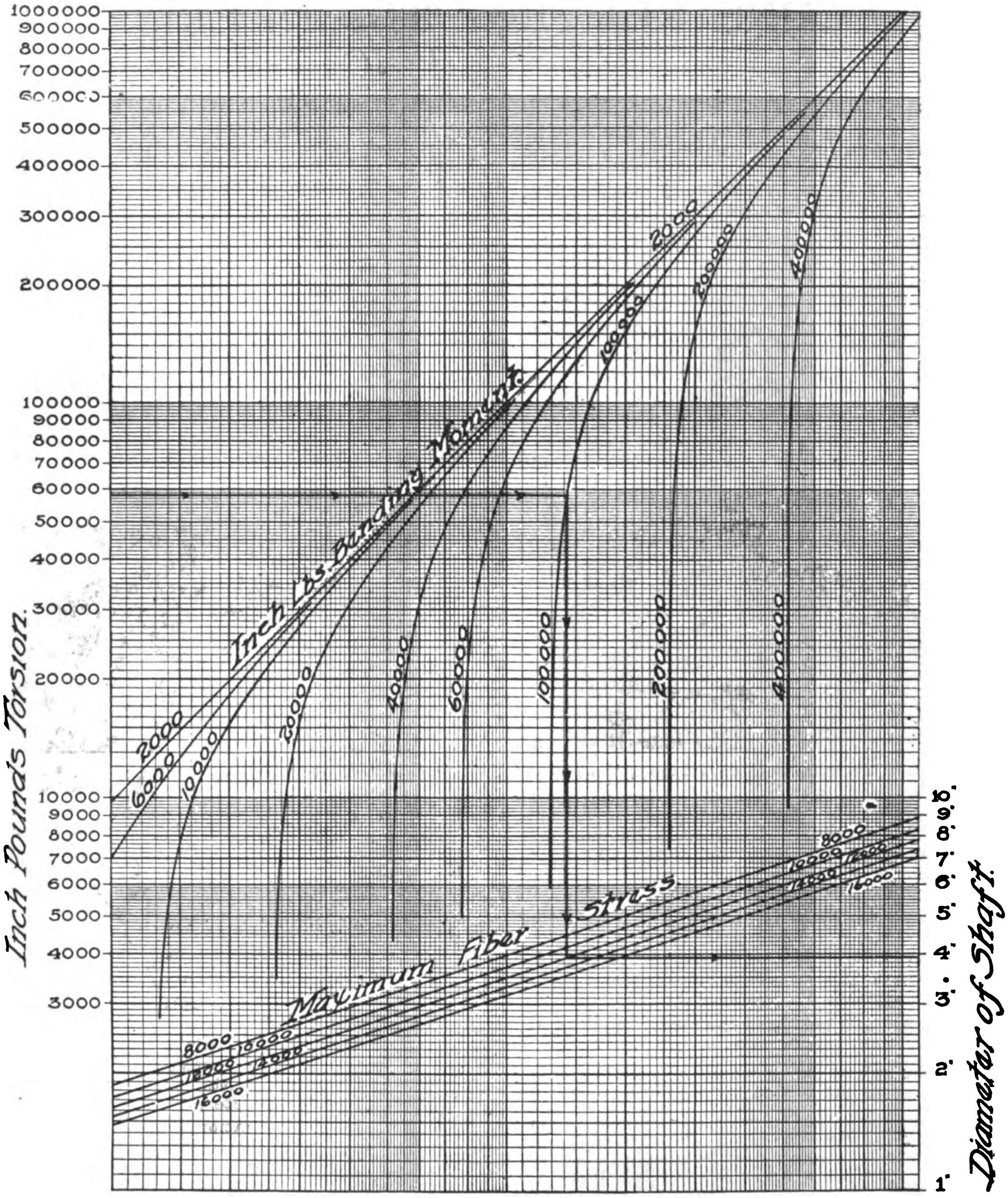


Chart for Finding Shaft Diameters for Combined Bending and Torsion



THIS chart for finding the proper size of shaft under combined bending and torsion is based on the following formula for equivalent torsion proposed by Prof E. L. Hancock and discussed by him in The Engineering Record of October 9, 1909:

$Te^2 = T^2 + 4\frac{a^2}{b^2}M^2$, in which

T = Torsion
M = Bending moment
Te = Equivalent torsion

$4\frac{a^2}{b^2}$ = Coefficient derived from relation existing between torsion and shear at elastic limit of material. This coefficient has been taken as 1.66 for mild steel, as suggested in the article referred to.

USE OF CHART. To find shaft diameter when the torsion in inch lbs. and bending moment in inch lbs. are known: Enter at the left with the known torsion, follow horizontally until the curve representing the known bending moment is intersected, thence down to the line representing the maximum fibre stress being used, and read at the right margin the desired diameter of shaft in inches. The heavy line indicates a solution for 58000 inch lbs. torsion, 100000 inch lbs. bending moment and a fibre stress of 12000 lbs. per sq. inch, showing a 3-$\frac{15}{16}$" shaft to be necessary. The fibre stress to be allowed is a matter of judgment with the designer. 10000 to 12000lbs. will generally be found suitable for small and ordinary sizes, but is rather higher than necessary for large sizes.

This Chart has not been published hitherto.

Courtesy Robins Conveying Belt Co.

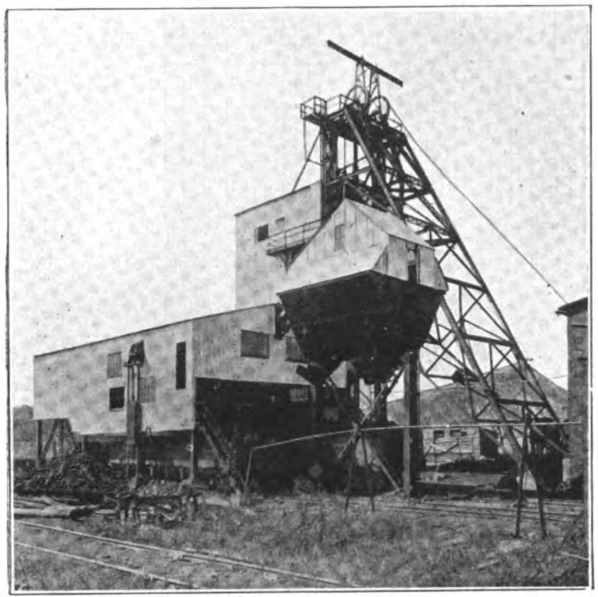
ALLEN & GARCIA COMPANY

McCormick Bldg. Chicago Ill.

CONSTRUCTING ENGINEERS

Our Policy

To put coal mine engineering and construction on the **right basis.** Not a business of machinery salesmanship, but **a constructive profession** involving the general and detail planning of an entire installation, the design, selection and scientific purchasing of the right machinery, and construction work done by experts in **each line.**



Chicago, Wilmington & Franklin Coal Co.'s Tipple, Thayer, Ill.

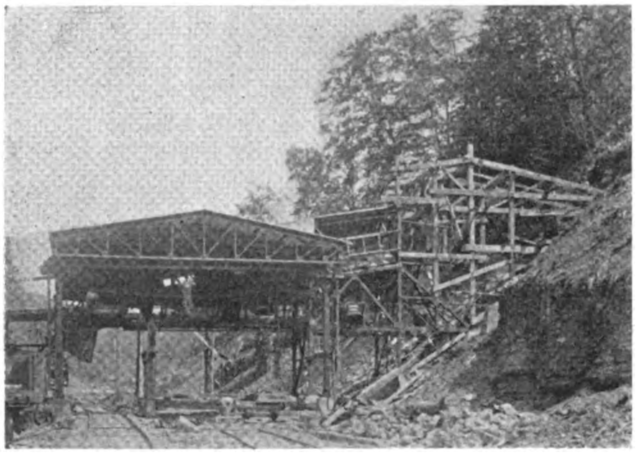
We have no interest in the sale or use of any particular kind or make of machinery We purchase for our clients, on merit only. We accomplish your results in the most economical way. The less machinery the better. Efficiency in maintenance and economical operation rather than low **first cost.**

Some of the Things We Have Done and Are Now Doing See Cuts

We have perfected the "Peterson Pendulum Hanger" for shaker screens, doubling the screening efficiency and saving more than half the power.

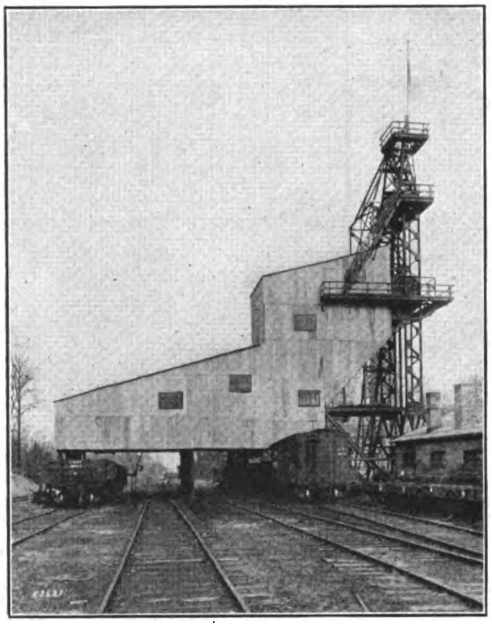
We have developed and perfected the center crank drive, reducing vibration, maintenance and power.

We have revolutionized the methods of handling mine car trips on drift, slope and incline installations by the use of the solid end car, the continuous trip, the automatic trip feeder and cager, the swivel coupling and the latest improved rotary dump.



Columbus Mining Co. No. 4, Hazard Ky., During Construction.

We have perfected a remarkable application of the above, to shaft mines by means of a self dumping skip, which greatly increases the output, and reduces rope speed so greatly that all the hazard and expensive features of rapid hoisting are eliminated and the process becomes as regular and reliable as the operation of a mine fan.



J. K. Dering Coal Co. Tipple, Mine No. 6, Clinton, Ind.

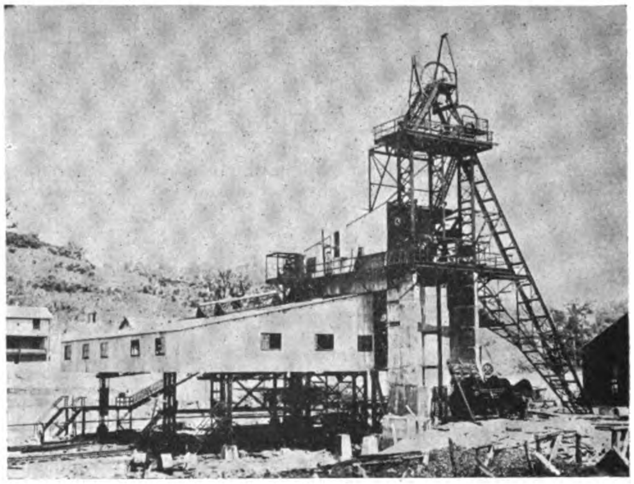
Our Specialties

Everything for coal mining; tipples, washeries, rescreeners, mine buildings, wash houses, cages, skips, power installations, electric hoists, steam hoists, electric wiring and transmission, complete plants.

Prospecting, examinations and reports, power surveys, operating economies.

Our Terms

Cost plus percantage or fixed fee based on the actual or estimated cost of work Consulting, examinations or special work on reasonable per diem basis.



Consolidation Coal Co. Mine No. 87, Fairmont, W. Va., During Construction.

DEMPCY-DEGENER COMPANY

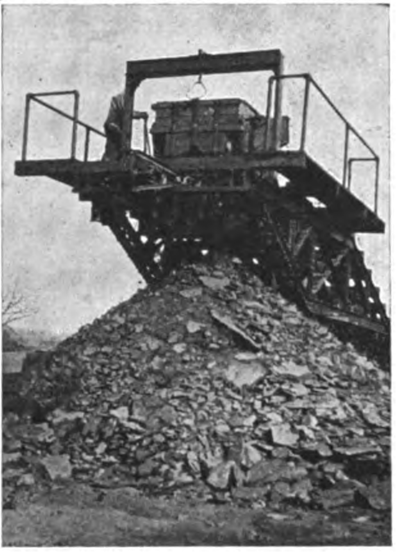
PITTSBURGH, PA.

Contracting Engineers
Transmission, Conveying and Elevating Machinery

Products

We design and construct Saxon Moveable Slate Dumps (Patented); Coal Tipples, Coal Washeries; Coal Bunkers; Belt Conveyors; Drag Conveyors; Bucket Elevators; Flight Conveyors; Skip Hoists; Car Hauls; Pivoted Bucket Conveyors; Electric Tramways; Crushers; Screens; Larries; Automatic Weighing Equipments.

Saxon Moveable Slate Dump (Patented)
for economical handling of mine refuse. Saves labor, eliminates all timbering, reduces space required for refuse pile, releases cars promptly.



The Saxon Movable Slate Dump consists of a Movable Cantilever tipple, which overhangs the dump and deposits the dumping sufficiently far ahead so that it makes its own roadbed. It is fitted with an electric rope hoist having a drum capacity of approximately 1000 of wire rope, which hauls the loaded cars from any convenient point, dumps them and delivers them back to the empty track. It is possible for two men to dump slate at the rate of from 20 to 40 cars per hour. In other words, the machine hauls and dumps the cars, and with it one or two men should easily handle all the slate under ordinary conditions.

The dump may be operated on a steep incline, thus very largely increasing the capacity of a given piece of property for the storage of refuse.

It is possible to handle on this machine either the mine cars themselves or else to dump the mine cars into a chute or bin and from this load the refuse into skip cars, which are then hauled and dumped by the machine.

Special advantages of the Saxon Moveable Slate Dump are:

It is almost never necessary to use more than two men for handling the entire output of refuse at the mine. In case the amount is small and length of haul short, one man can easily do the work.

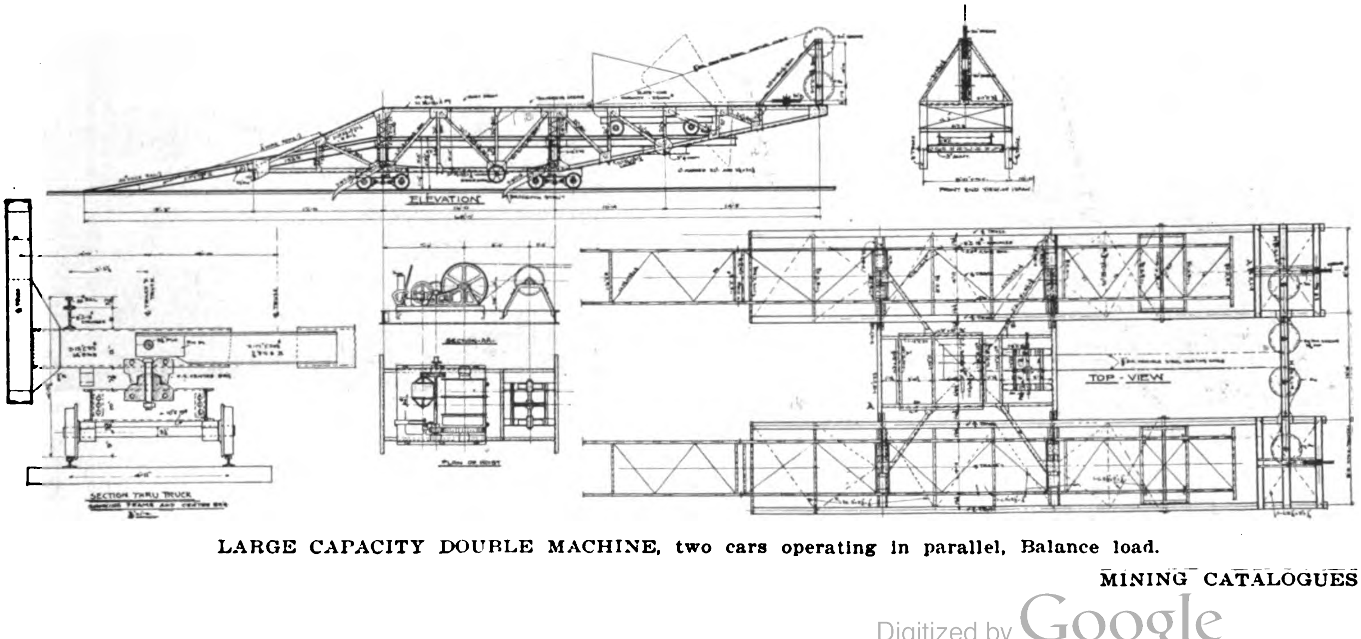
The two regular operators can move the dump forward when it becomes necessary, level the roadway and lay tracks in about one and one-half hours.

The control of the machine is where it should be, i. e.—at the dumping point, enabling the operator to take care of any difficulties which may come up, such as choking of materials in cars, etc., as well as avoiding the danger of running the cars off the pile in cases where the hoisting machinery is distant from dumping point.

Installations

The following is a list of satisfied users:

Carnegie Coal Co., J. H. Sanford Coal Co., Cowanshannock Coal & Coke Co., Pittsburgh & Erie Coal Co., Jamison Coal & Coke Co., National Mining Co., Upper Lehigh Coal & Coke Co., Clyde Coal Co., Allegheny River Mining Co., Pursglove-Maher Coal Co., Pittsburgh Coal Co., Union Coal & Coke Co., Valley Camp Coal Co.



LARGE CAPACITY DOUBLE MACHINE, two cars operating in parallel, Balance load.

FAIRMONT MINING MACHINERY CO.

Standard Equipment.

- Tipple Structures
- Screens and Chutes
- Loading Booms
- Picking Tables
- Conveyors—all types
- Cable Car Hauls
- Chain Car Hauls

General Offices and Works

FAIRMONT, W. VA

TRADE MARK REGISTERED

FAIRMONT

(The Mark of Quality.)

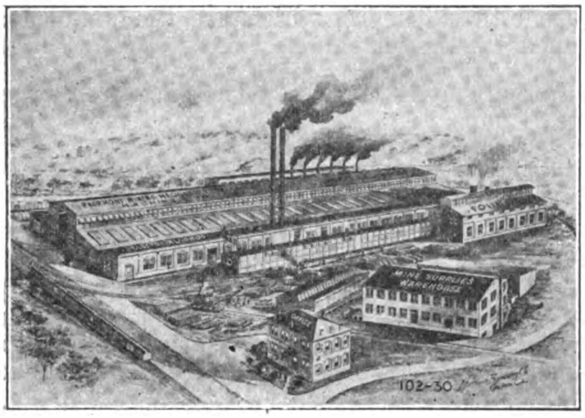
Specialties

- Steel Mine Ties
- R. R. Car Retarders
- Portable—
- Electric Mine Pumps
- Power Coal Augers
- Box Car Loaders
- Mine Car Trucks

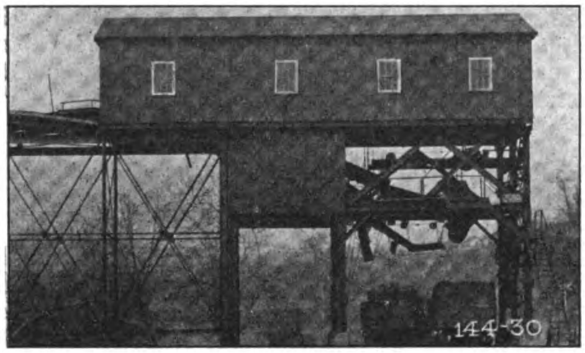
COAL MINE EQUIPMENTS

Fairmont Steel Tipple and Complete Screening and Loading Boom Equipments are designed and built to meet all conditions for the best possible preparation and loading.

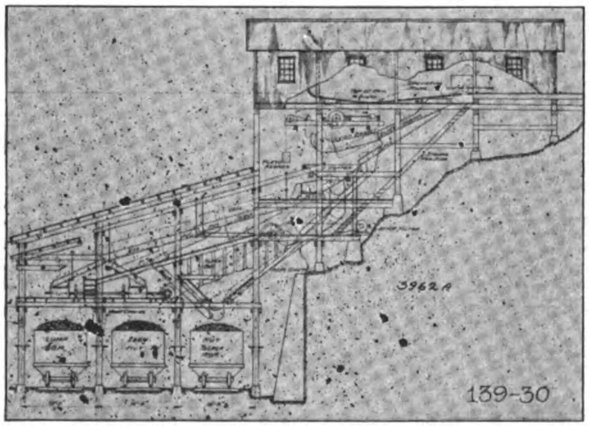
We will gladly furnish information as to where any of the following plants can be seen in operation. Our Engineering Department is at your service.



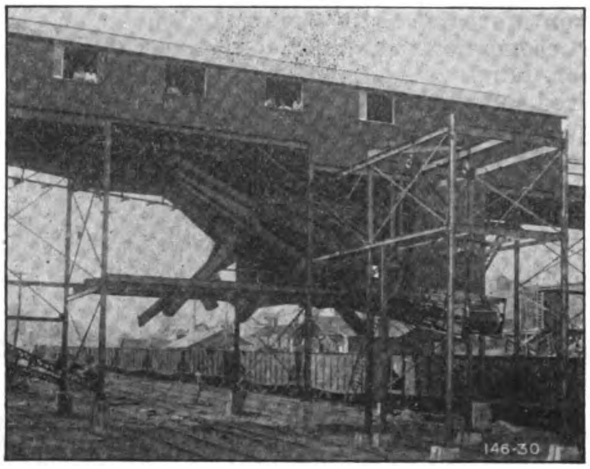
Home of Fairmont Products.



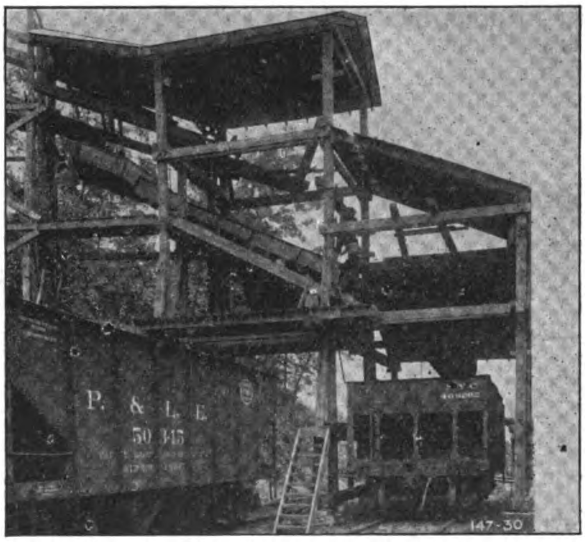
Complete steel tipple with 500-ft. rope car haul across West Fork River and gravity screening equipment installed for Marion Gas Coal Co. at Ringamon, W. Va. Capacity 200 tons per hour.



Tipple equipped with Weigh Basket, Apron Feeder, Shaking Screens and Lump and Egg Loading Booms. Capacity 250 tons per hour.

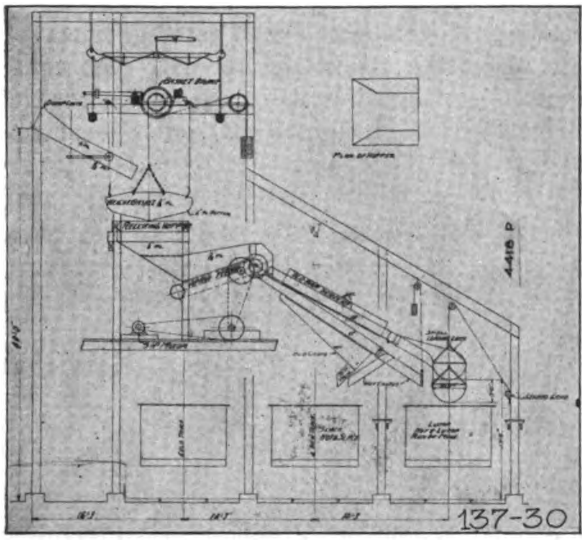


Double tipple equipment erected for the Meadowlands Coal Co. at Arden Mines, Pa. Is arranged with car pusher for caging empties and bringing loads to cross over dumps, one dump emptying into a weigh basket and loading boom, the other into a weigh basket and directly into the car. Empty mine car is returned by chain haul to car pusher and cage.

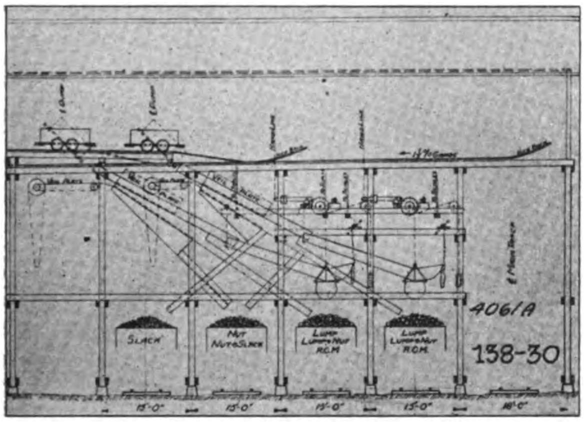


View of the end of a Rope and Button Conveyor and Gravity Screen Equipment erected for the Pittsburgh, Chartiers & Youghiogheny Coal Co. at Thornburg, Pa. Capacity 100 tons per hour.

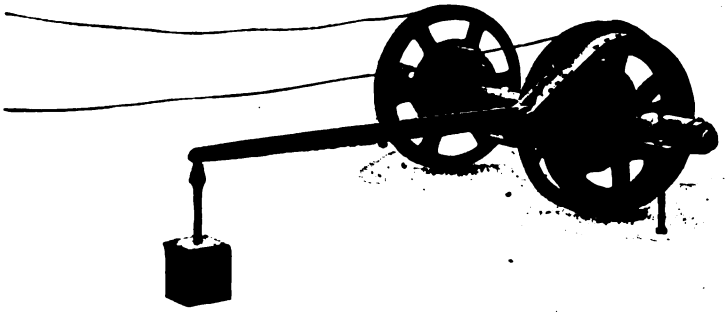
Coal Handling Equipment



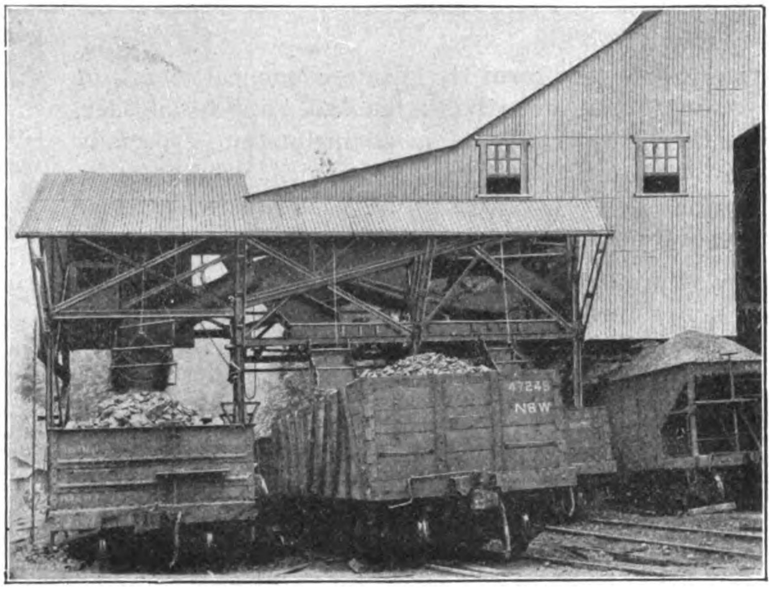
Typical two-track tipple equipment with center dump weigh basket, apron feeder, gravity screen and spiral chute.



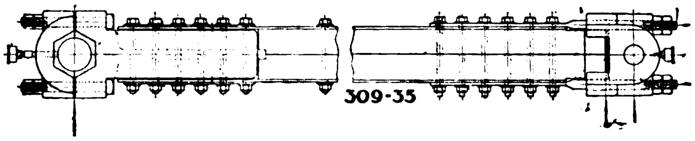
Typical four-track tipple equipment with double screens, with sliding veils, dump basket and end loading chutes.



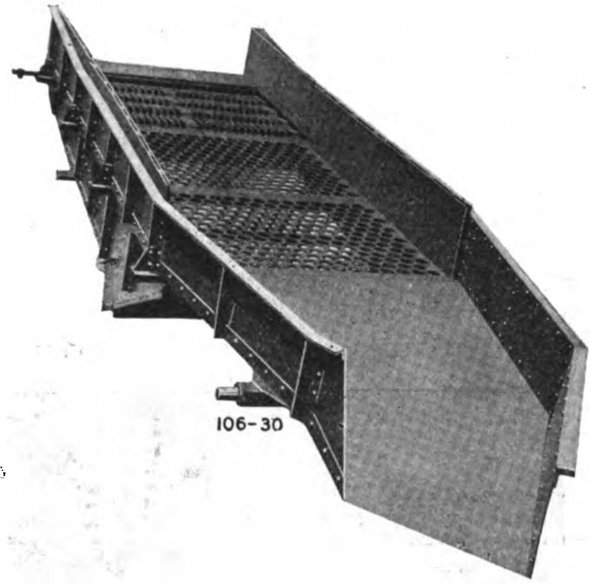
Controlling device for operating the drums for regulating the lowering of the dump-baskets. These may be seen in place over the two right tracks in the illustration on the upper left. They are operated from the trimmers platform, are made in any capacity, either single or differential to suit conditions.



Shaker screen equipment erected for Jewett, Biglow & Brooks Coal Co. at Twin Branch, W. Va., equipped with tandem double deck shakers and end loading booms on lump and nut tracks.



The connecting rod used on our shaker screen dirve is designed to give the correct amount of resilience to avoid unnecessary shocks and breakage of coal, the crank end is equipped with removable bronze bushings, the oiling arrangement is most complete.



Lower leaf of Shaking Screen showing both perforated and lip screens and also our bevel nose discharge which lays the coal, well distributed, without breakage on the loading boom.

Coal Handling Equipment

Pan Conveyors

Conveyors form the most economical means of transporting materials from one point to another, either horizontally or on an inclination, especially if the service is to be continuous. Suitable designed conveyors are entirely automatic in their operation and need very little attention.

Our apron conveyors are constructed with 6-inch, 8-inch, 12-inch pitch chain and pans, and are designed to meet all the conditions where this type of conveyor is suitable or desirable—for Picking Tables, Loading Booms or combination Loading Boom and Picking Table and Loading Boom, and for elevating coal or lowering it to the tipple.

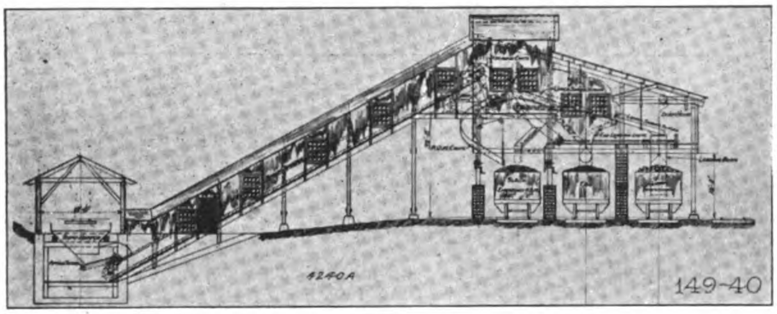


Fig. 1.

When the coal seam is on the level of the railroad track, or below, this layout is used with great economy. The coal is dumped into a hopper and fed onto a pan conveyor, which may serve as a picking table, which elevates it and delivers to the shaking screens in the tipple, where it is carefully sized and the lump loaded by our loading boom.

Construction

The construction of the drive and other parts is very substantial, as the illustrations show. The head sprockets are made of either cast iron with the tooth faces chilled to resist wear, or of cast steel, as the conditions of service require. The gears, bearings and takeups are of especially heavy section to resist the strains of service. The conveyor chain is supported on self oiling wheels with case hardened steel bushings or roller bearing wheels.

Fig. 2 shows a combination picking table and loading boom installed by us.

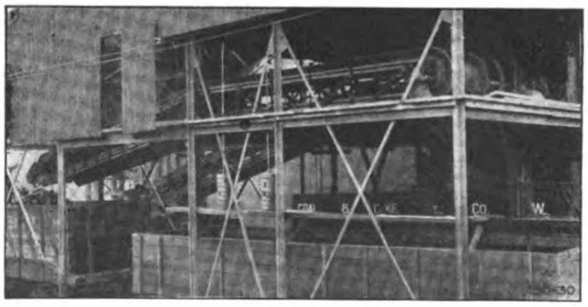


Fig. 2.

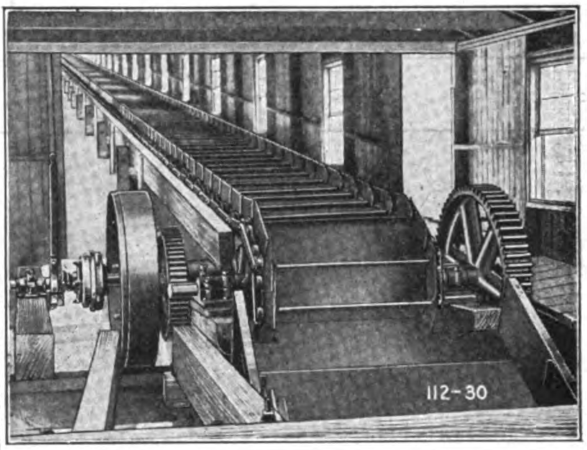


Fig. 3.

Fig. 3 shows the construction and design of the head sheave, showing drive, clutch and discharge arrangement.

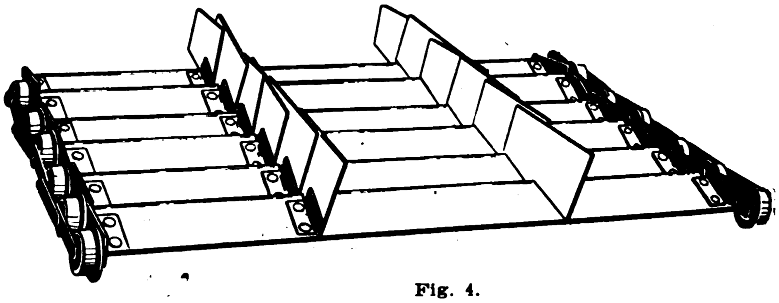


Fig. 4.

Fig. 4 shows section of our Three-Compartment Picking Table, designed to carry three grades of coal from the screens, or two grades with space for throwing the slate, or for picking run-of mine coal, in which case the middle section is usually used for slate.

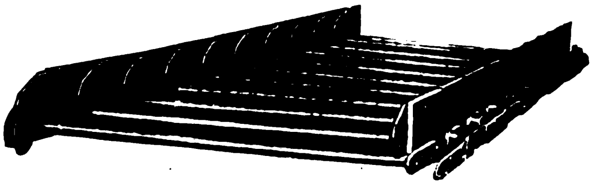


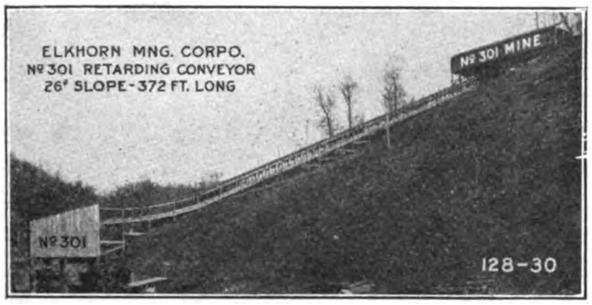
Fig. 5.

Fig. 5 shows section of the pans and chain, showing the method of joining the pans and chain as well as the supporting wheels.

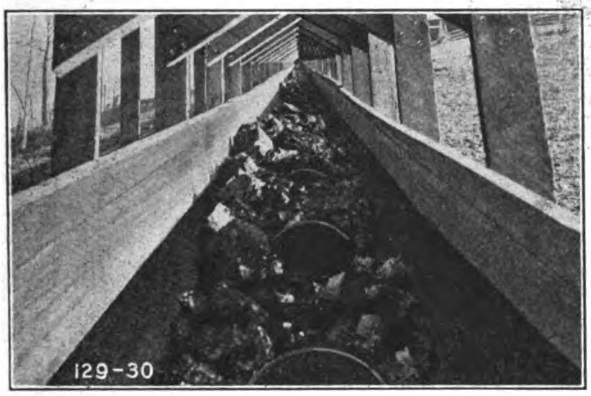
FAIRMONT Coal Handling Equipment FAIRMONT

Rope and Button Conveyors

Rope and button conveyors are used for lowering run-of mine coal and other material down an incline. They are more economical for pitches from 15 to 30 degrees and lengths of 150 feet and over. They may be used on flatter pitches and in this case are cheap in first cost but require more power to operate. Under certain conditions they are successfully used on steeper pitches than 30 degrees.



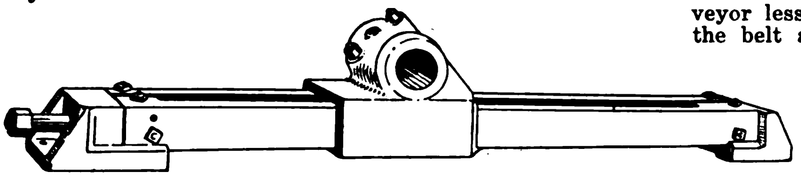
Whole equipment installed by us.



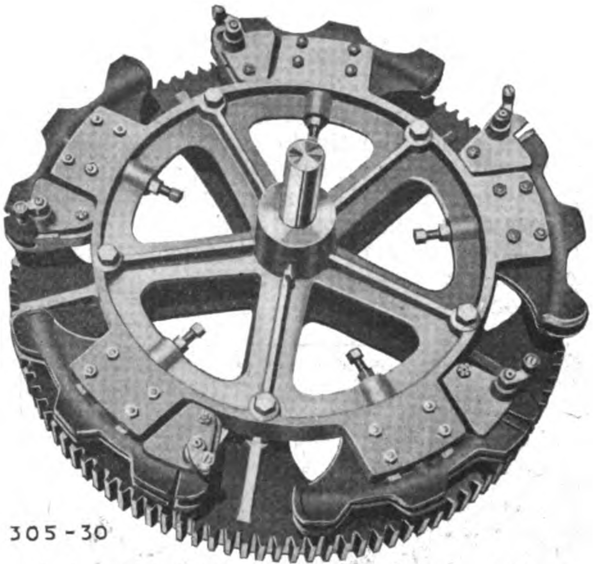
Looking Down.

We use on our conveyors specially designed head and foot sheaves which take care of the stretch in the rope without respacing the buttons. The head sheave shown in the illustration is provided with a device which disengages the buttons from the sheave pockets without jerk or jar.

A specially designed discharge chute is employed with our disc conveyors which is so arranged that the coal in leaving the conveyor to the chute is not accelerated. While this is usually arranged at the foot or lower end of the conveyor, it may be located at any intermediate point. Some illustrations of equipments that have been built by us are shown, but space does not permit lengthy descriptions and we refer you to our Conveyor Bulletins.



Takeup for Rope and Button Conveyor.



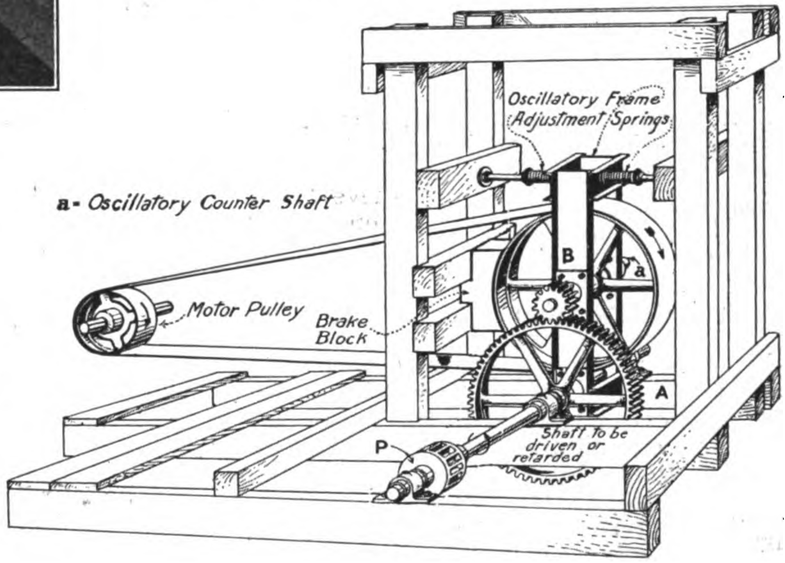
Recording Tooth Head Sheave for rope and button conveyors.

Automatic Conveyor Brake

The Automatic Brake shown in the illustration below is for the purpose of regulating the speed of rope and button and other types of conveyors used to convey coal or other material down a slope, and which when loaded require a break and when empty require power. In both cases it is entirely automatic.

Operation

Assuming that a conveyor for lowering material down a slope is connected to this drive and moving in the direction indicated and that owing to its load, breaking is necessary, it will be seen that the acton of the gear A moves the frame and consequently the belt pulley toward and into contact with the brake block. As soon as the speed of the conveyor lessens, the motor begins to deliver power through the belt and the pinion B. The reaction of this pinion against the gear swings the pulley and frame away from brake block. When the conveyor needs power, as when the conveyor is starting or running empty, this reaction keeps the belt pulley away from the brake block. If the belt breaks or the power goes off, the pull of the conveyor will apply the brake and bring the machine to a stop.


Oscillatory Frame Adjustment Springs
a- Oscillatory Counter Shaft
B
a
Motor Pulley
Brake Block
A
P
Shaft to be driven or retarded

The Automatic Brake installed.

TRADE MARK REGISTERED **FAIRMONT**

Railroad Car Retarder

TRADE MARK REGISTERED **FAIRMONT**

Fairmont Car Retarder

The Fairmont Railroad Car Retarder is the best apparatus on the market for handling railroad cars under the tipple. It insures safety to the trimmer under all conditions, affords a great economy in wages, saves much delay to cars running away, or being stalled under the tipple, and due to its ability to move the cars short distances, it saves much of the breakage of coal due to loading.

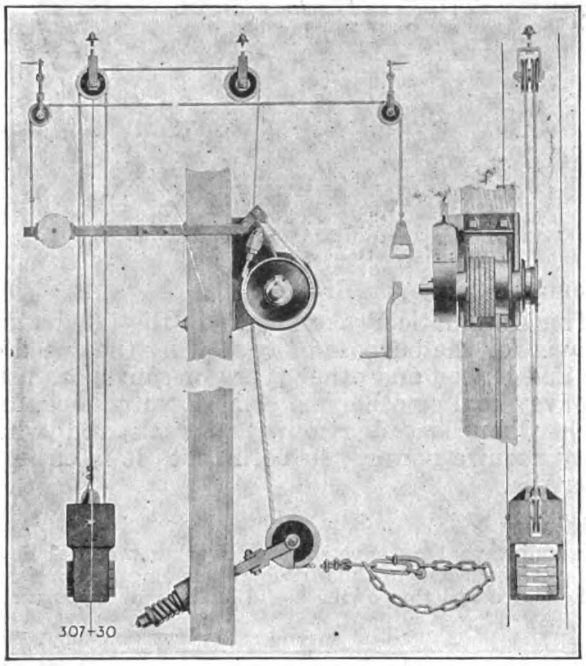


Fig. 1.

Safety

Regardless of snow, sleet, rain and bad brakes the railroad car is always under the absolute control of the responsible man.

Economy

At least one man may be relieved in practically all cases, representing a profit on the investment of over 300% per year.

Method of Operation

For the most successful operation the track should have enough grade (about 2%) so cars will run without being barred or pushed. When the first car is lowered to the upper end of tipple the hook on end of main line is attached to car at most convenient point on front truck. Car is then dropped down to loading point by pulling hand line "C," which raises brake lever "D" and releases brake, allowing car to go forward as far as desired. The car is stopped by releasing hand line, which allows weight on brake lever to apply the brake. As the car is loading this operation is repeated several times, lowering the car a few inches at a time to keep coal up against loading chute or boom. When car is lowered to point where main line is about all off the drum, the hook is released from car the counterweight "B," which has raised as the main line comes off the drum, drops down, reversing the motion of drum and automatically winding the main line back on drum, in position to attach to next car.

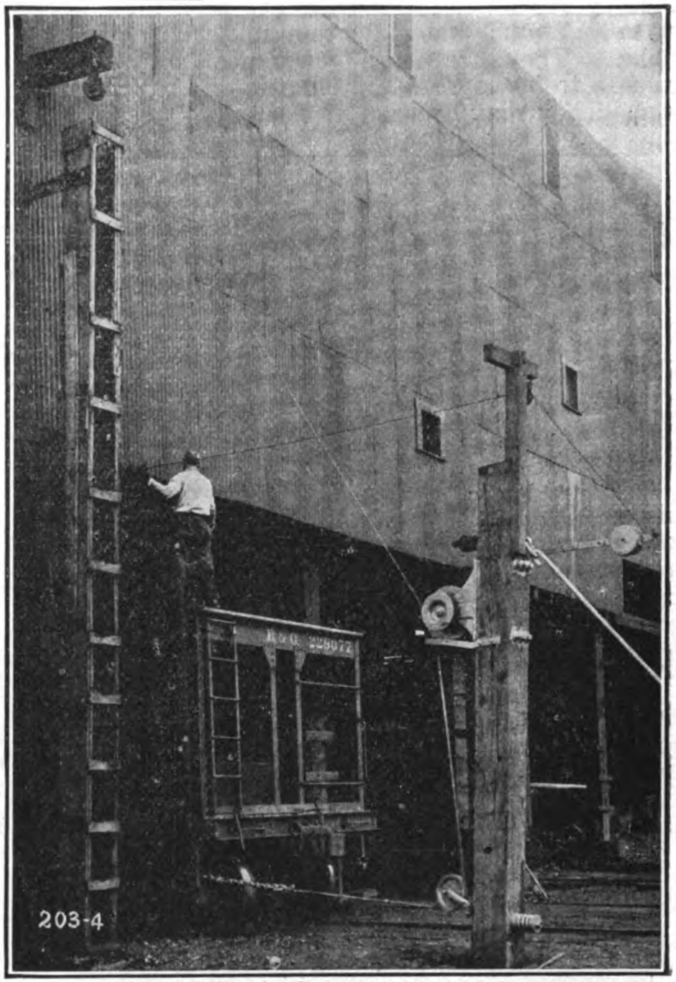


Fig. 2. Retarder Assembled.

The counterweight "B", and hand hold "C". for operating brake, can be carried to any convenient point by means of small sheaves provided for the purpose; and if desired the Retarder can be operated from two or more different locations.

Fig. 3 shows the Retarder in operation where where one man is handling the control of four tracks from one position.

Construction

All parts are constructed amply strong to withstand the strain when starting and stopping cars. Double buffer springs are provided to take the shock off the post and retarder when cars are stopped. The main rope is $\frac{5}{8}$-inch plow steel, giving the maximum strength for the size.

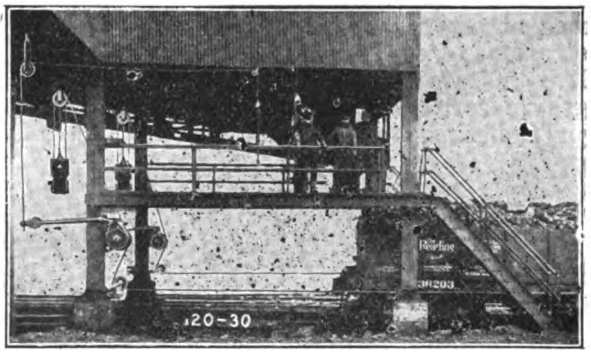


Fig. 3. Retarder and Guide Sheave on Same Post.

HEYL & PATTERSON, INC.

ESTABLISHED 1887 PITTSBURGH, PA.

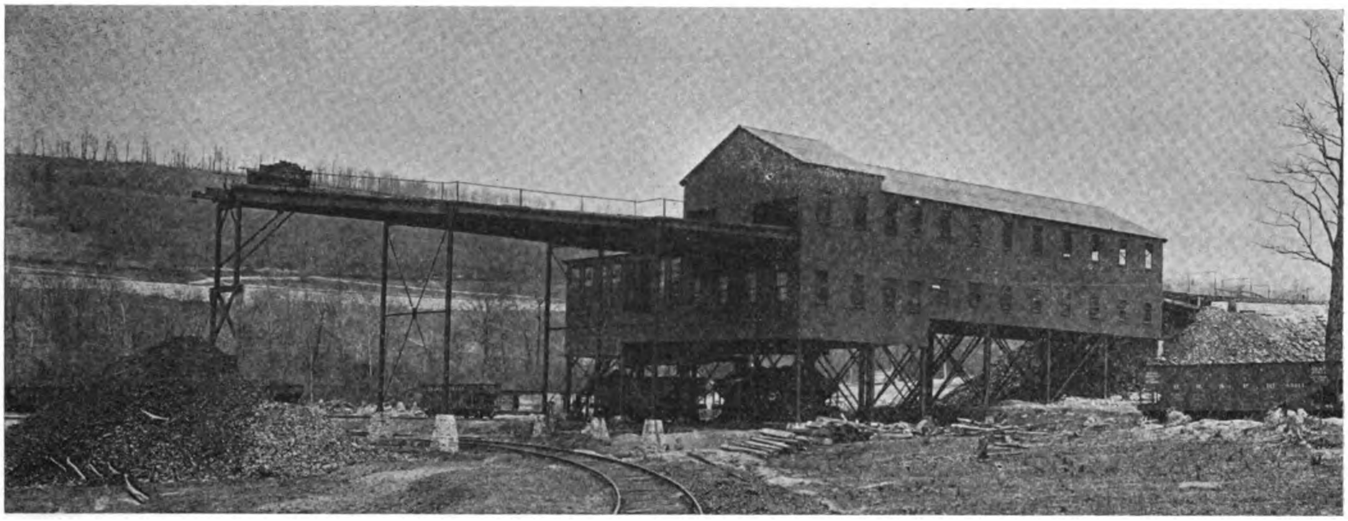
Contracting Engineers

For Coal Mines

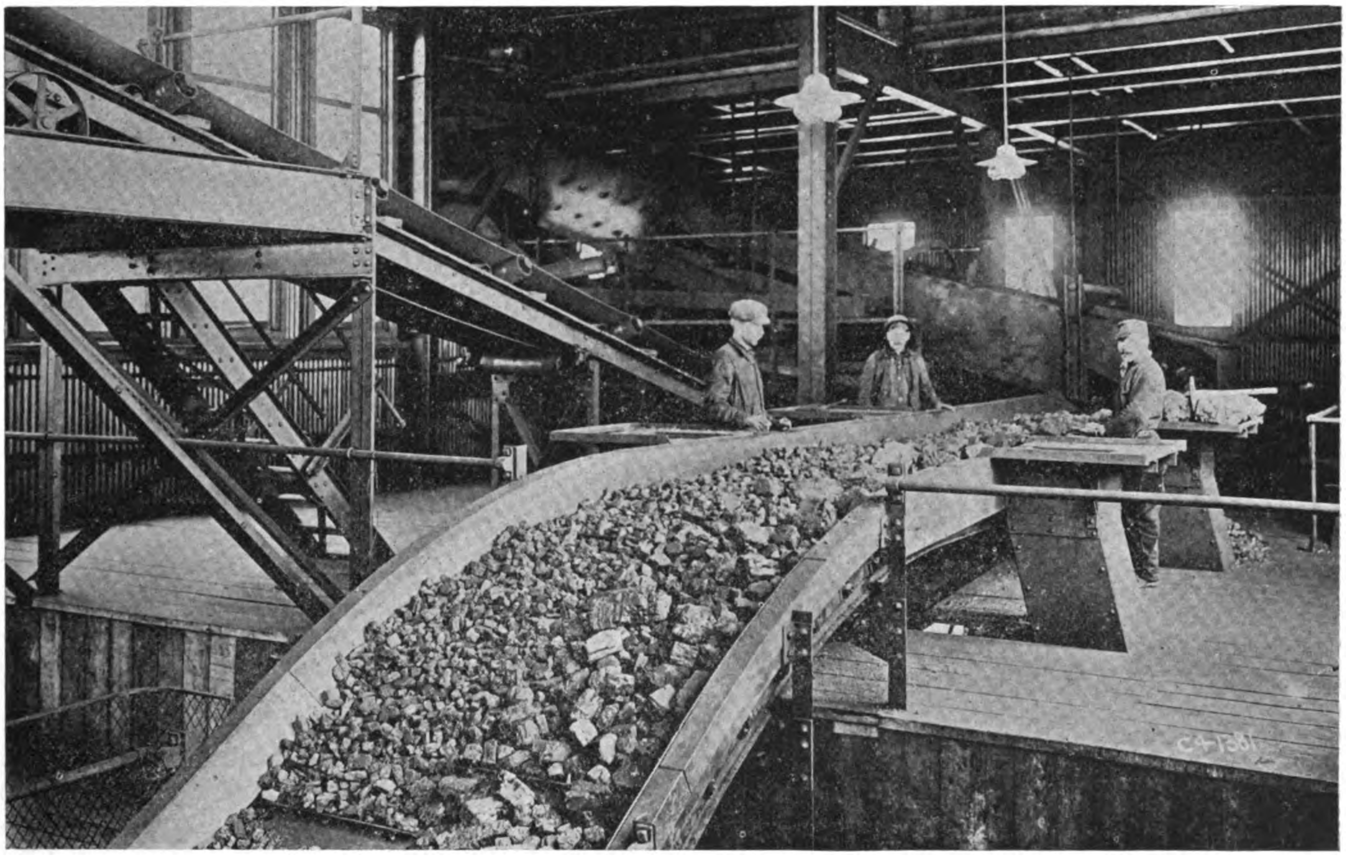
- Complete Tipples
- Car Hauls
- Revolving Dumps
- Coal Crushers
- Bradford Breakers
- Storage Bins
- Refuse Stacking Cars
- Coal Washing Plants

For Docks and Storage Yard

- Man Trolley Bridges
- Rope System Bridges
- Unloading Towers
- Anthracite Storage Sheds
- Screening Plants
- Grab Buckets
- Rope Haulage Systems



Coal Tipple and Picking House.



Interior of Picking House.

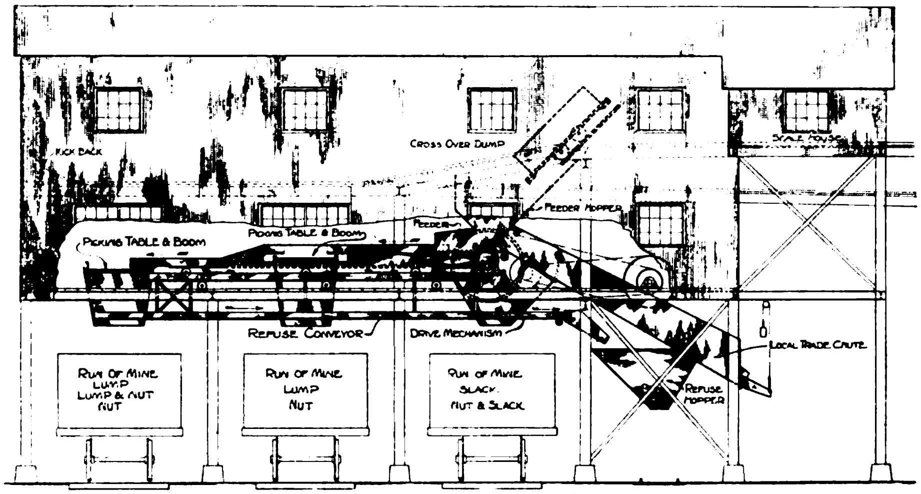
JACOBSEN & SCHRAEDER, Inc

Marquette Building
CHICAGO

ENGINEERS
Consulting---Designing---Contracting

Specialists In

- Mining Plants
- Tipples
- Washeries
- Screening Plants
- Storage Plants
- Industrial Plants
- Elevating
- Conveying
- Power Transmission



Jacobsen Three Track Tipple.

EQUIPMENT
(Patents Pending)

The **Jacobsen Patent Balanced Horizontal Screen and Picking Table** and the **Jacobsen Patent Tipple Design** form the most efficient combined Screening and Picking Equipment and insure a perfect product properly loaded.

The Jacobsen Patent System

Is the most efficient method of handling coal with a minimum of breakage.

A high percentage of large sizes is assured. NO RESCREENING EQUIPMENT IS REQUIRED.

The Jacobsen Patent Screen

Is DISTINCTIVELY SIMPLE in CONSTRUCTION and OPERATION. It is a BALANCED SCREEN and therefore REQUIRES NO COSTLY REINFORCED CONCRETE FOUNDATIONS.

The Jacobsen and Schraeder Equipment

Is characterized by
SIMPLICITY,
EFFICIENCY and ECONOMY.

SERVICES

Your Engineers

The Thoroughness, Promptness, and Experience of your Designers and Engineers conduces largely to your success.

The service of our organization which is available to you involves:—

An Extensive Experience and Knowledge in this Particular Service and Field.

Thorough and Prompt Attention to all work submitted.

Your Tipple and Washery

Submit your problems and requirements to our engineers.

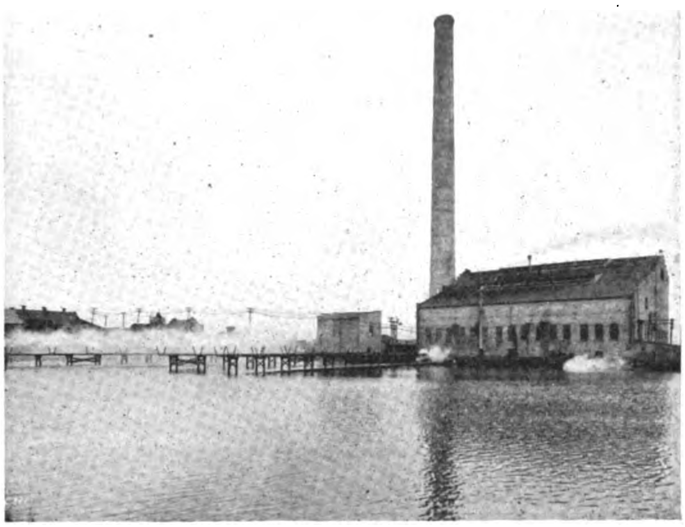
Every Tipple and Coal Washery submitted to us is carefully considered and every detail is designed to meet the particular conditions, requirements and results involved.

KREHBIEL COMPANY

1712 Marquette Building, Chicago

ENGINEERS-CONSTRUCTORS

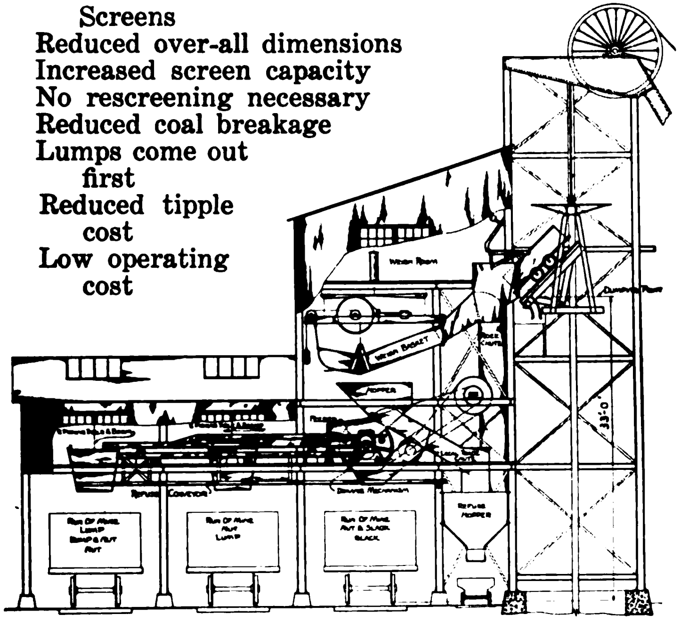
Complete Top Works For Coal Mines Including Complete Electrical Systems



Mine Power Plant and Cooling Pond, Christopher, Ill.

Tipple Features

- Jacobsen Balanced Shaker Screens
- Reduced over-all dimensions
- Increased screen capacity
- No rescreening necessary
- Reduced coal breakage
- Lumps come out first
- Reduced tipple cost
- Low operating cost



Jacobsen Three Track Tipple—Patents Pending.

Preparing Systems and Picking Tables
    Jacobsen Patents and Designs

Tipples
- Steel
- Timber
- Combination
- Jacobsen Patents

Hoists
- Steam
- Electric

Power Plants
- Steam
- Hydraulic
- Electric

Buildings
- Frame
- Mill Construction
- Fireproof

Washeries

Concrete Shafts

Power Investigations

THE JEFFREY MANUFACTURING COMPANY

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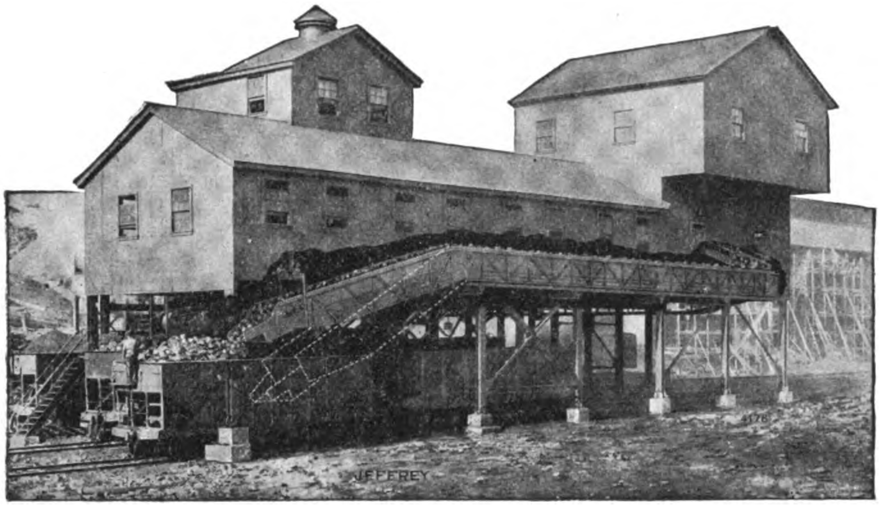
Scranton, Pa..Union Nat. Bank Bldg.
Broadwell, O........H. H. Townsend
Middlesboro, Ky..Middlesboro Hotel
Charleston ....West Virginia
Cleveland..421-423 Rockefeller Bldg.
Chicago ....McCormick Bldg.
St. Louis...Railway Exchange Bldg.
Milwaukee............M. & M. Bldg.
Denver....First National Bank Bldg.
Seattle.............L. C. Smith Bldg.
Birmingham......Brown-Marx Bldg.
Dallas..........................
..Commonwealth Nat. Bank Bldg.
Canadian Works ....Montreal

Coal Handling Machinery

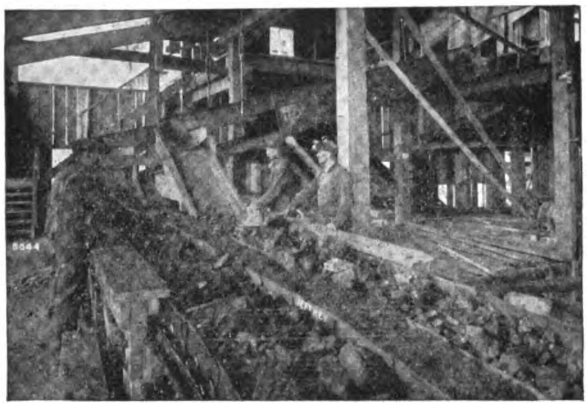


Modern Tipple Equipment, showing Jeffrey Combined Picking Table and Adjustable Loading Boom.

Jeffrey Coal Picking Tables and Adjustable Loading Booms insure the delivery of a perfectly prepared product, free from impurities and excessive breakage.

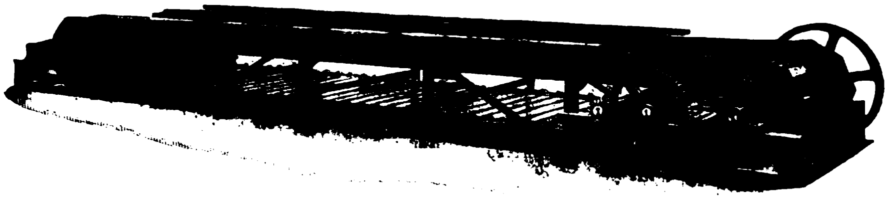
They can be applied or built into your **old** or **new** tipple with very little alteration in the general tipple construction.

Double Beaded Flight Apron Conveyor Delivering Coal From Mine; Upper End Used for Picking Table.



Jeffrey Picking Tables are made with Single, Double, or Treble Compartments, as illustrated.

Send for Illustrated Bulletin No. 45-A.



Picking Tables are furnished complete ready to operate—Steel aprons furnished with and without supporting structure or driving machinery.

In addition to the Tipple Machinery Equipment illustrated, we manufacture a complete line of

Continuous Type Bucket Elevators;
Steel Apron Carriers;
Endless Pan Carriers;
Rubber Belt Conveyors;
Pivoted Bucket Carriers;
Chain Scraper Conveyors;
Valves and Spouts;
Feeders;
Loading and Unloading Devices.

A complete line of accessories for Elevating, Conveying and Power Transmission Machinery.

Every purchaser of Tipple and Coal Mine Machinery should have a copy of our latest general catalog.

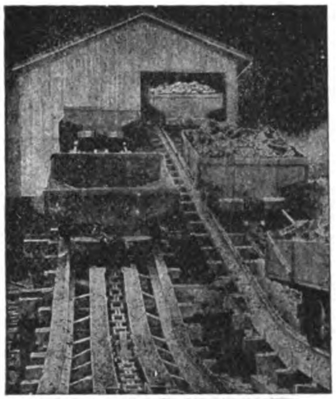
THE JEFFREY MANUFACTURING COMPANY

Coal Handling Machinery

The Jeffrey Wire Cable Car Haul is especially adapted to the continuous haulage of Mine Cars. It is smooth running. It uses little power.

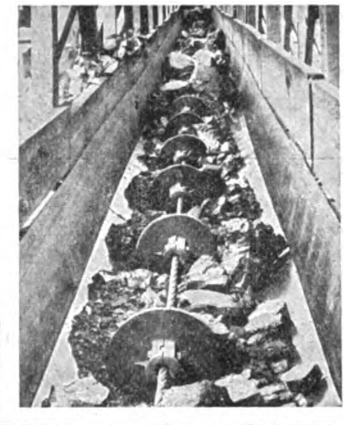
We also furnish Chain Car Hauls.

Ask for Special Car Haul Bulletin.



A Jeffrey Cable Haul-Up handling Four Cars per Minute to a Cross-over Dump in Tipple. One single endless cable both elevates the loads and lowers the empties.

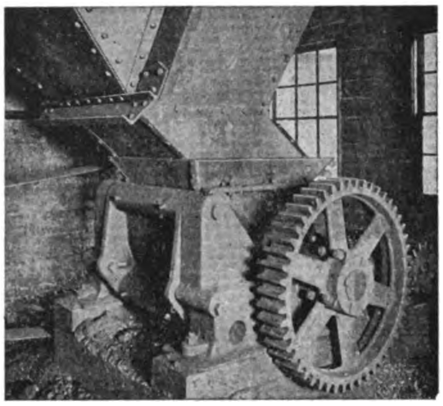
A Jeffrey Wire Cable Conveyer operating in a V-Shaped Trough, lowering upwards of 200 tons per hour.



A Jeffrey Cable Retarding Conveyer of several hundred feet centers from Dump House on an upper level to Tipple Building in the Valley.

The Jeffrey Cable Conveyer solves the problem of lowering coal over great distances from high elevations to Tipple or Loading Tracks. It simply maintains a uniform speed to the free sliding of the coal. Does not break the lumps.

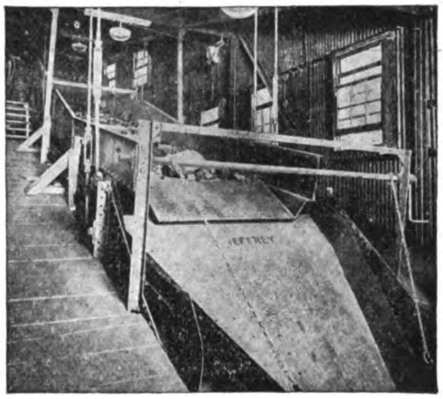
Write for Retarding Conveyer Bulletin.



A 30 x 60 Single Roll Crusher, at the mines of the Pocahontas Consolidated Collieries Co., W. Va.

The Jeffrey Single Roll Coal Crusher is a daily increasing necessity at the coal mine. A single operation Reduces Run-of-Mine Coal to that Uniform Stoker Size, which means a maximum of efficiency under the boiler.

Send for Crusher Bulletin No. 141-62.



Tandem of Shaking Screens, with Adjustable End Loading Chute, for loading direct or by curved chute into cars.

Coal Tipple Screens and Chutes—made to order from designs and specifications furnished to us, or from our Standard Equipments.

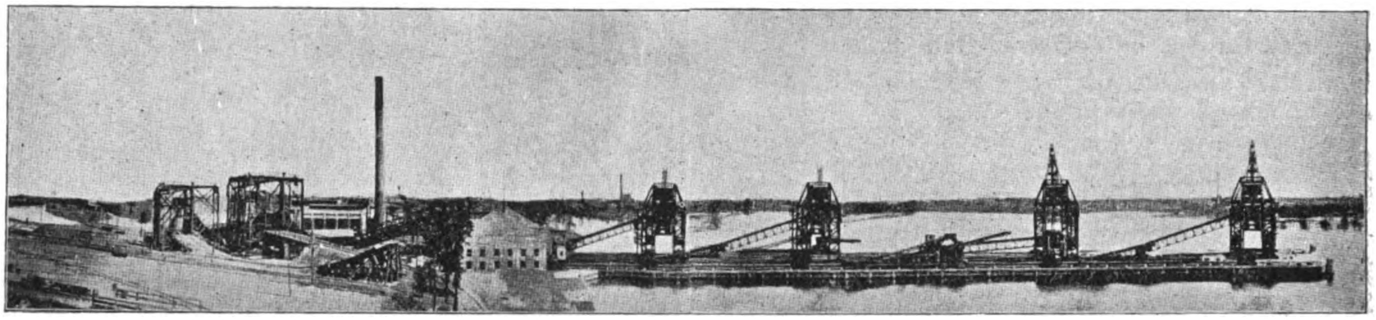
Revolving Screens of Wire Cloth or Perforated Metal also furnished.

Write for Screen Bulletin No. 69-B.

INTERNATIONAL CONVEYOR CORPORATION

50 EAST 42nd STREET
NEW YORK

Baltimore Office,
1529 Munsey Bldg.



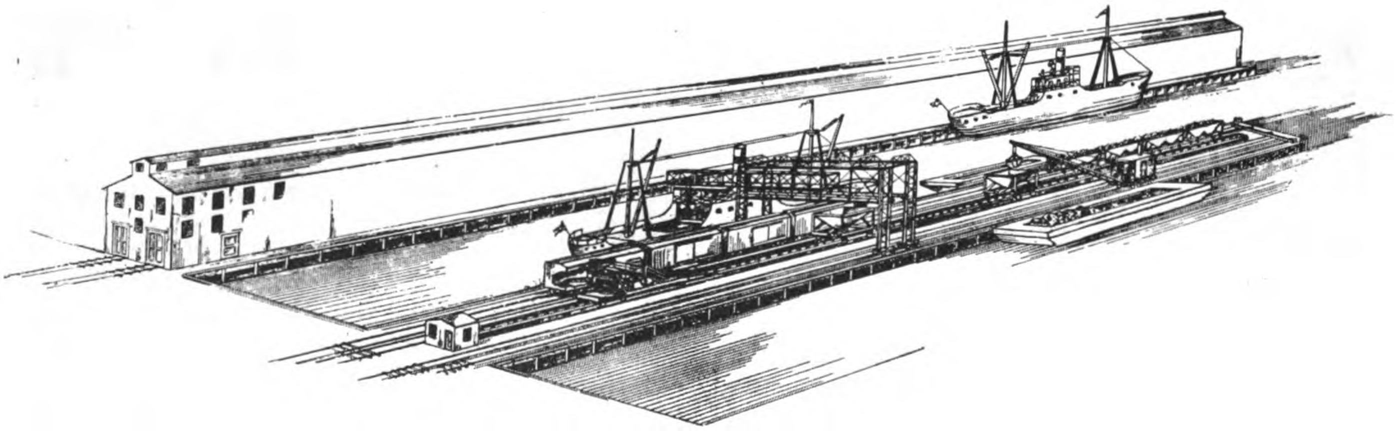
Stuart System of Vessel Loading, Baltimore & Ohio R. R. Coal ing Pier, Curtis Bay, Maryland.

A Corporation formed in realization of the existing need and growing demand for the improvement of terminal service and facilities; and an organization effected to aid in the development, along systematic lines, of principles, methods and systems for the loading, storing and shipping of materials handled in bulk from the source of supply to final delivery.

This company owns or controls various methods, including the Stuart System of mine storage, car loading, terminal storage, vessel loading, and other means which have been developed by experience for the rapid and economical handling of materials.

It is prepared to undertake the conception and design of the required installations, to construct or supervise the construction of new plants, or the improvement of existing ones, and to organize, operate and manage systems of handling after completion.

This service is offered to those interested in the expansion and development of loading, unloading, storing and shipping facilities and their proper coordination with transportation and commercial requirements.



Stuart System of Vessel Unloading, showing Box and Open Car Loader.

KANAWHA MANUFACTURING CO.

CHARLESTON, W. VA.

Kanawha Tipple Equipment

Products

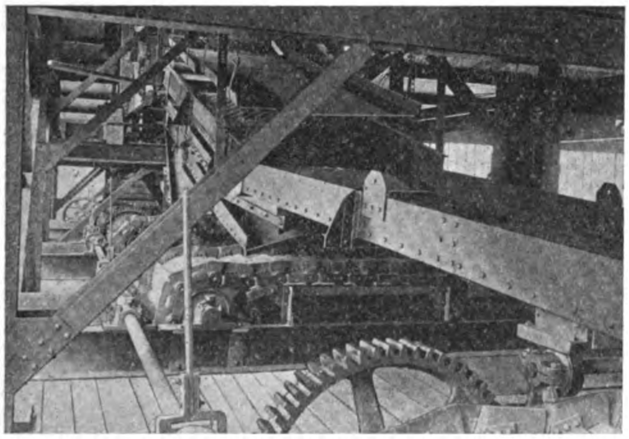
Drums, Monitors, Mine Cars, Conveyors, Dumps, Feeders, Shaking and Rotary Screens, Picking Tables, Loading Booms, Elevators, Gearing, Sheaves, Etc.

To the Oparators

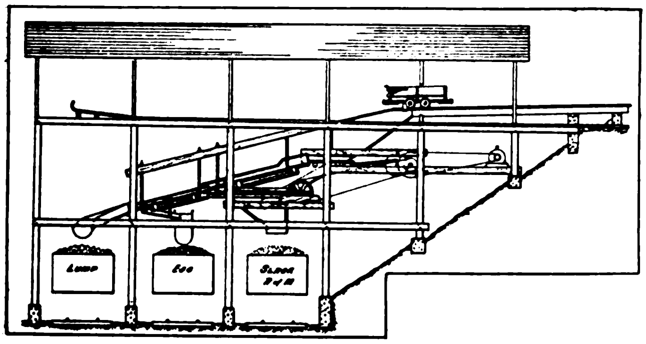
Our Engineering Department is at your service and is prepared to solve your coal-handling problems and furnish estimate of cost. Complete timber plans with bills of timber and bolts furnished without additional cost on all work awarded us.

Construction

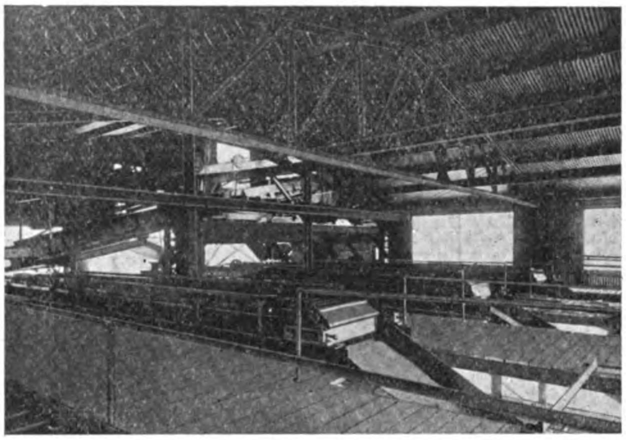
Our Construction Department, located at Charleston, W. Va., is completely fitted up with the latest improved machinery, and is in position to manufacture the entire equipment, including chutes, curves, screens, loading booms, or any parts you may need in the least possible time.



Head of Picking Tables Under Shaking Screens.



Three Track Tipple Without Boom.

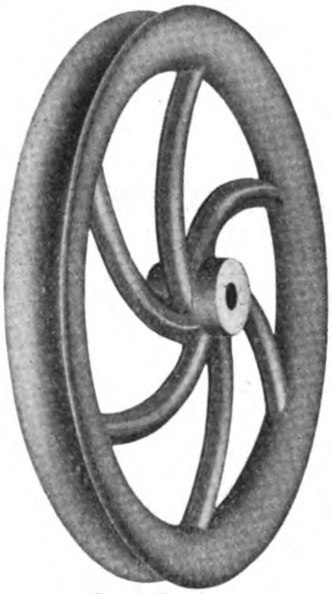


Shaking Screens with Picking Tables.

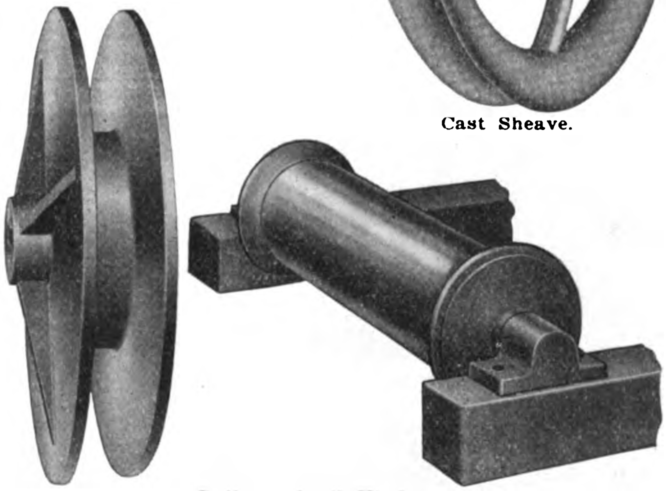
Castings

Our large, well equipped foundry and pattern shops are prepared to supply your needs, either stock or special designs of

- Rollers
- Sheaves
- Gears
- Pinions
- Brake Shoes
- Coke Oven Castings
- Grate Bars
- Pillow Blocks
- Boxes
- Frogs and turnouts
- Fly Wheels
- Etc., Etc.



Cast Sheave.



Rollers of All Kinds.

LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

Complete Equipment for the Handling and Preparation of Coal

New York...............299 Broadway
Pittsburgh.........1501 Park Building
Boston..................49 Federal St.
St. Louis...Central National Bank Bldg.
Buffalo.............698 Ellicott Square
Wilkes-Barre..2nd National Bank Bldg.
Detroit...........732 Dime Bank Bldg.

Seattle.........576 First Avenue South
Portland, Ore.........1st and Stark Sts.
Los Angeles.....161 N. Los Angeles St.
Denver.......Lindrooth, Shubart & Co.
Minneapolis...........418 So. Third St.
Knoxville, D. T. Blakey...Empire Bldg.
Cleveland........429 Rockefeller Bldg.

New Orleans, C. O. Hinz.............
.................Hibernia Bank Bldg.
San Francisco..........461 Market St.
Birmingham.......McCrossin & Darrah
Louisville, Frederick Wehle, Starks Bldg.
Toronto...Canadian Link-Belt Co., Ltd.

Products

We design and build complete Coal Tipple Equipment, Coal Washeries, Retarding Conveyors, Rescreening Plants, Shaking Screens, Picking Tables, Loading Booms, Chutes, Automatic Coal Driers, Locomotive Cranes, all types of Elevators and Conveyors, Transmission Machinery, Electric Hoists, Etc.

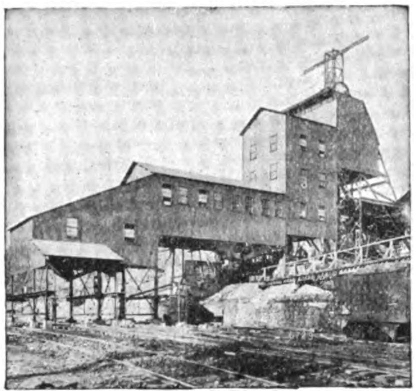
Catalogs will be sent to interested parties on request.

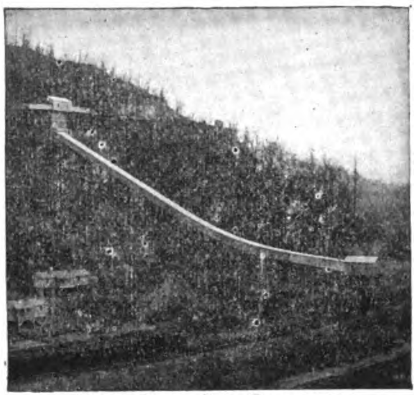
No. 313—Longwall Coal Conveyor.
No. 303—Some Modern Coal Tipples.
No. 304—Increasing Profits by Saving Expense in the Handling and Storing of Coal and Ashes.
No. 308—Blue Diamond Coal Co.'s Tipple.
No. 322—Powhatan Coal Tipple.
No. 165—Coal Tipples, Retarding Conveyors, Etc.
No. 120—Peck Carrier for Coal, Ashes, Etc.
No. 79—Belt Conveyors.
No. 106—Hoisting and Conveying Machinery.
No. 125—Link-Belt Silent Chain Drives.
No. 158—Locomotive Cranes.
No. 160—Retail Coal Pockets.

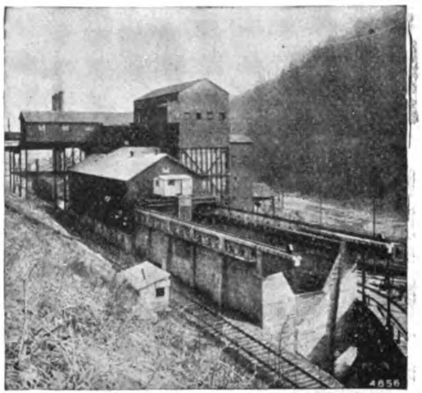
The success of Link-Belt Machinery is due to the fact that each equipment is designed by our experienced engineers, manufactured throughout in our own shops under their direct supervision, and erected by our own erecting corps, insuring personal supervision from the beginning to the completion of the work, and one responsibility.

Our three large manufacturing plants at Chicago, Indianapolis and Philadelphia are equipped with the most modern machinery for the fabrication of the structural work for steel tipples, screening equipments, chutes and all machinery necessary for handling and sizing coal.

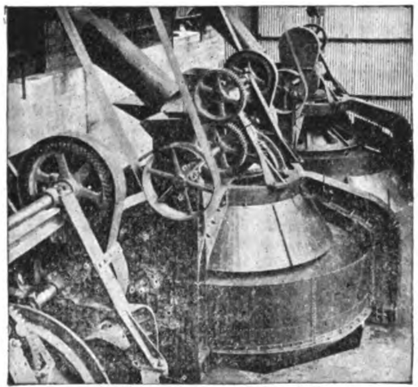
Our engineers are prepared to offer their services for the solution of all engineering problems. We are always pleased to send representatives, upon request.

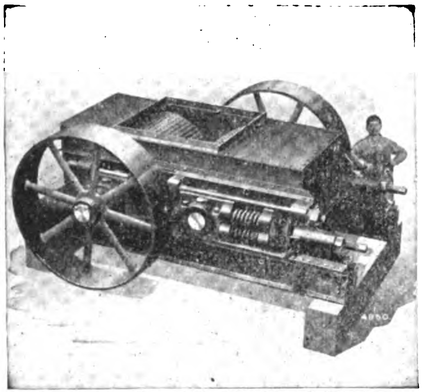

Steel Coal Tipple.


Chain Retarding Conveyor.

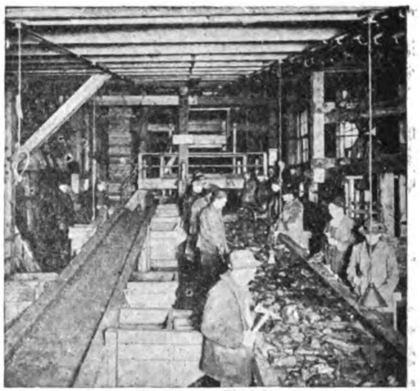


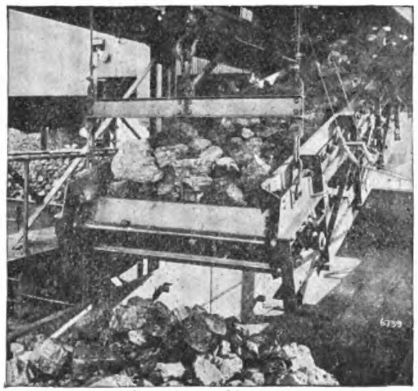
Coal Washery at Berwind, W. Va.


Wendell Centrifugal Coal Drier.

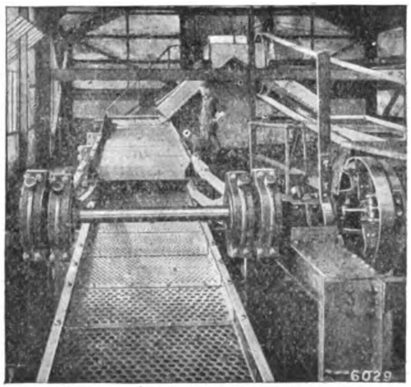


Crushers for All Kinds of Coals.

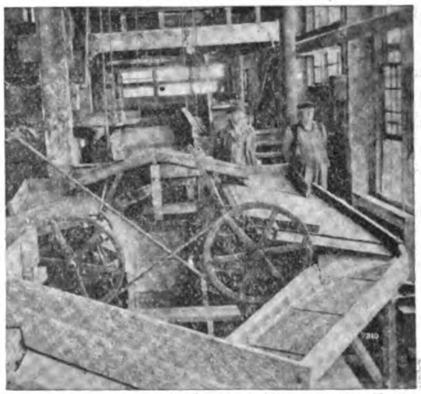

Picking Table.



Loading Boom.



Spring Leg Shaking Screen.


The Ayres Separator for Removing Slate from Anthracite and Bituminous Coal.

Marion Machine, Foundry & Supply Co.

Scottdale Branch
SCOTTDALE, PENNA.

Direct Representatives
CROCKWELL MINE & MILL SUPPLY CO., St. Louis, Mo.
S. H. MEEM & CO., Bluefield, W. Va.
J. F. DONAHOO CO., Birmingham, Ala.

Builders of

Complete Tipple Equipment

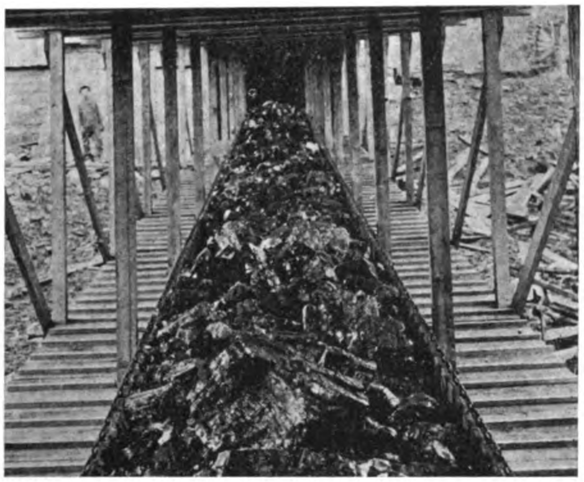


Fig. 1. View of steel apron conveyor, handling coal from dump to shaker in the installation shown in Fig. 3.

The planning and erection of complete equipments is our great specialty. Our wide experience in this class of work enables us to go into the work more thoroughly from your point of view.

For over forty years we have been doing this work, in wood and steel, and our customers tell us that our work is good and our prices right.

If this kind of service interests you we will be glad to furnish suggestions and figures on reguest.

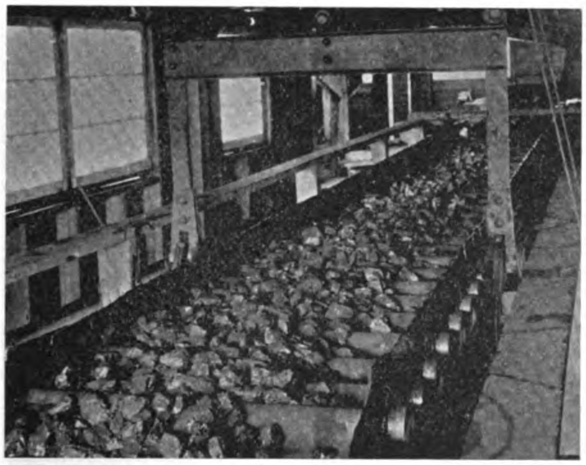


Fig. 2. View of egg loading boom above the tipple shown on the right. Boom is counter weighted and electrically operated.

Fig. 3.—General view of an installation for the Diamond Block Coal Co. at Hazard, Ky. Capacity 1200 tons per day. Prepares three sizes; loads either mine-run, lump, egg or slack or their combinations. Loading boom installed for lump only; egg size handled by our extensible loading chute.

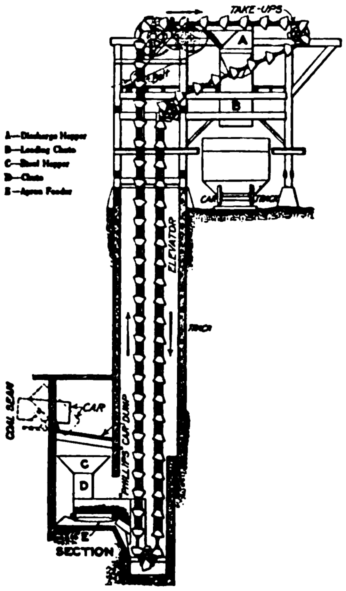


Fig. 4. Scottdale Shallow Shaft Elevator. Suitable for any capacity, for installations where the coal is 75 feet or less below the surface. The tipple can be arranged for loading one, two, three, or four size products.

The cost of installation, mainteance, and operation of this equipment is less than that of any other system of hoisting coal.

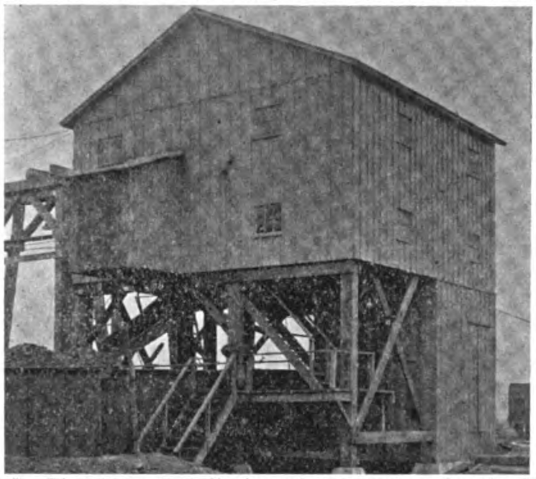


Fig. 5. This is an installation of this system for the Bradenville Coal Co. at Bradenville, Pa. Capacity 3 railroad car per hour.

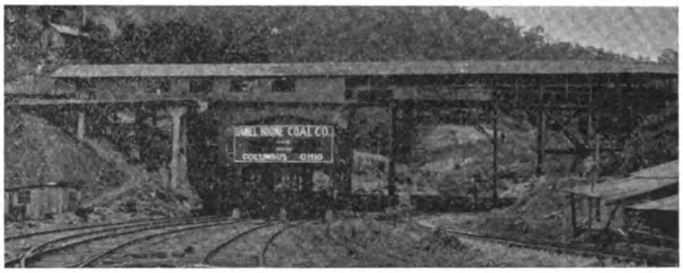


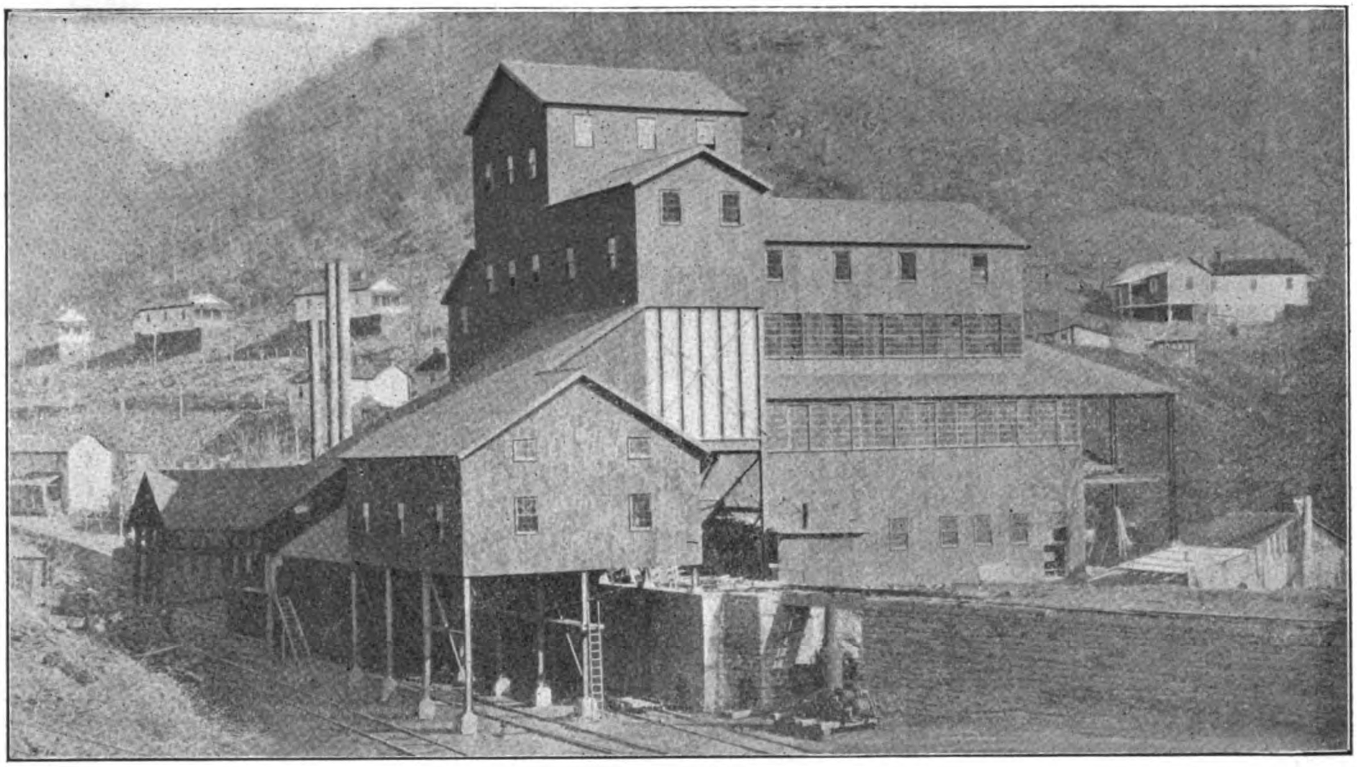
Fig. 6. General view of a double tipple for the Daniel Boone Coal Co. at Lennut, Ky. Capacity 150 tons per day; screens and loads out three sizes straight, or mine-run, or any of three combinations.

PITTSBURGH COAL WASHER CO.

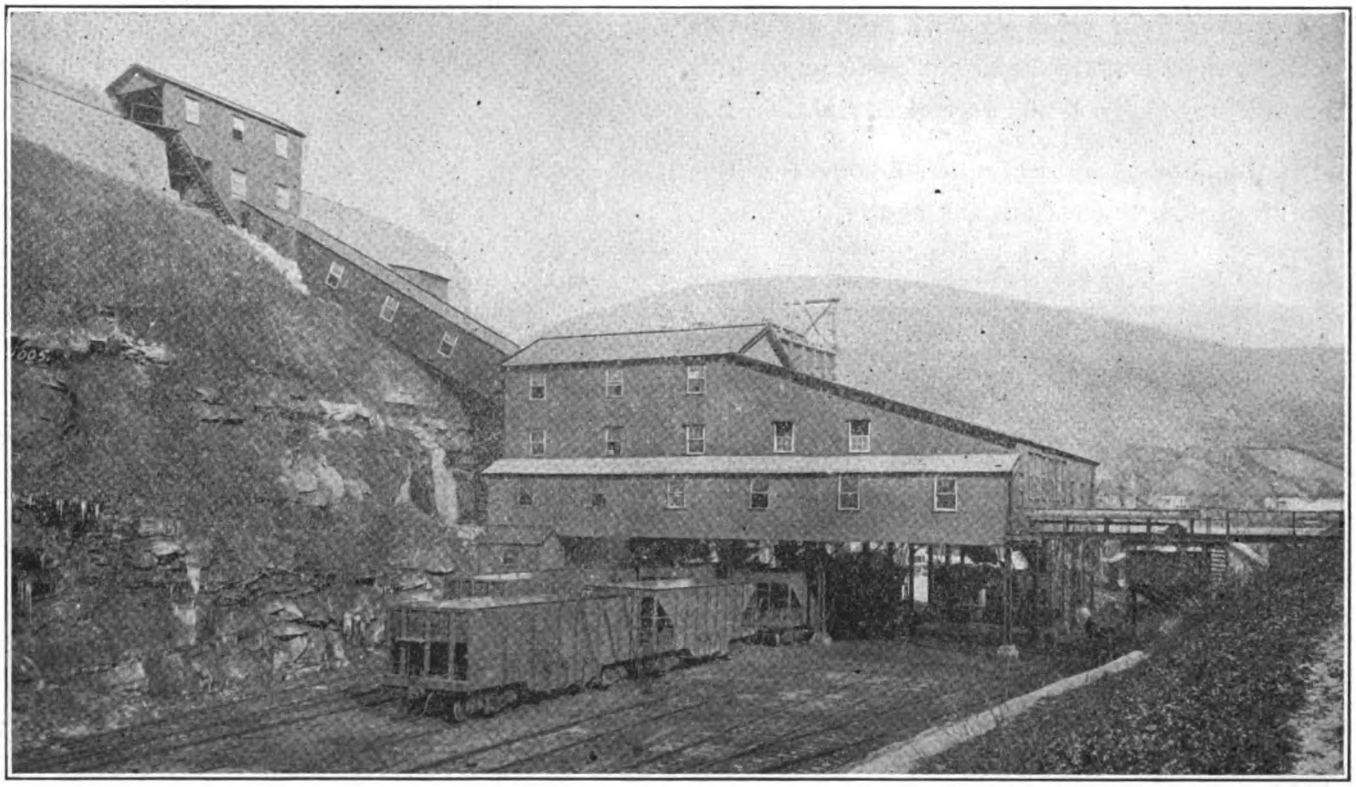
Office, Fulton Bldg. PITTSBURGH, PA. Works, Ambridge, Pa.

Engineers and Contractors

Manufacturers of Elevating, Conveying and Coal Washing Machinery



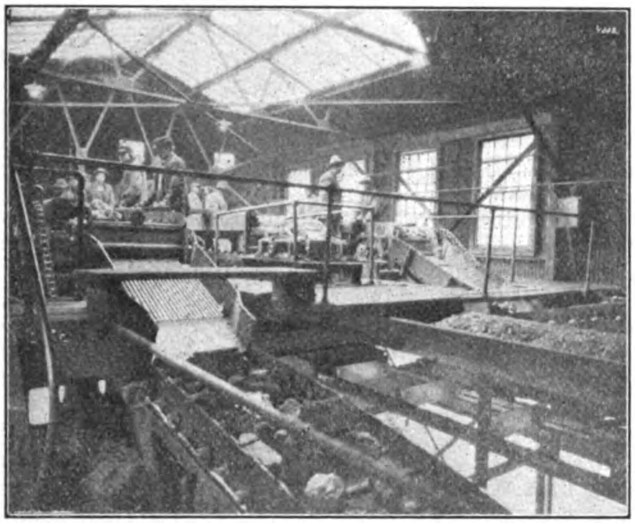
Modern Coal Washer and Tipple, Designed, Built and Equipped for the Indian Ridge Coal & Coke Co., Worth, W. Va.



Lick Branch Colliery, Designed, Built and Equipped for the Pocahontas Consolidated Collieries Co., Inc., Pocahontas, Va.

Products

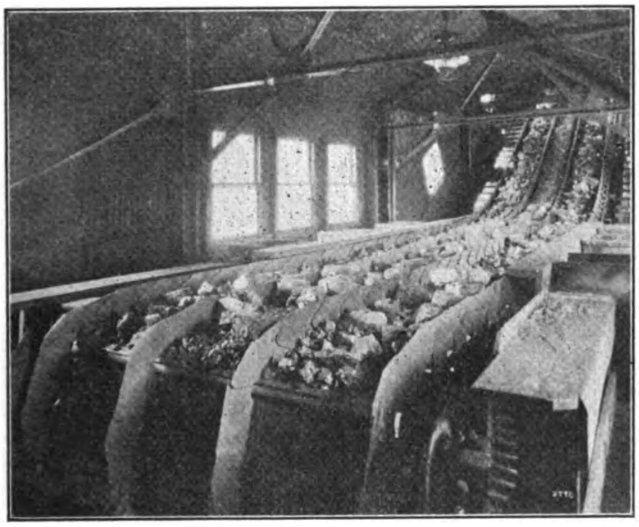
We manufacture the following products: Coal Tipples, Coal & Coke Handling Plants, "Improved" Pig Iron Casting Machines, Coal Washing Plants, "Pittsburgh" Jig (Recriprocating Type), "Pittsburgh Special" Jig (Plunger Type), Coal Crushers, Car Hauls, Picking Tables, Retarding Conveyors, Loading Booms, Electric Hoists, Shaker Screens, Gravity Screens, Spiral Lowering Chutes, Coaling Stations, Coal Elevators, Steel Thimble Roller Chains, Special Steel Chains, Double Beaded Conveyor Pans, Elevator Buckets, Sprocket Wheels, etc., etc., etc.



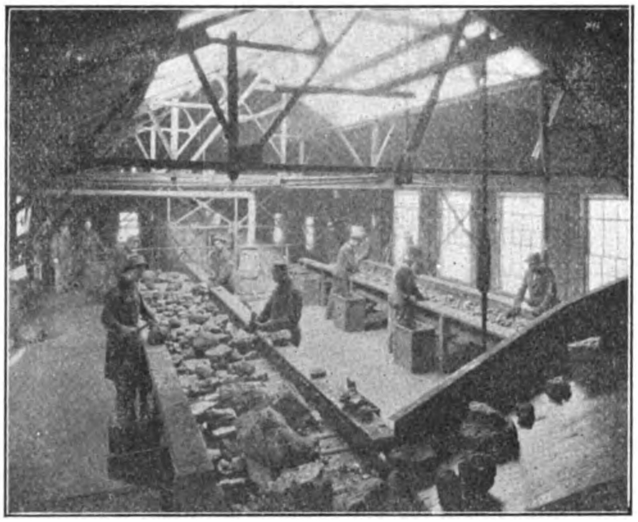
Lip Screen between Picking Tables and Loading Conveyors.

Construction

We are prepared to construct all plants designed and manufactured by us with up-to-date equipment and thoroughly experienced mechanics.



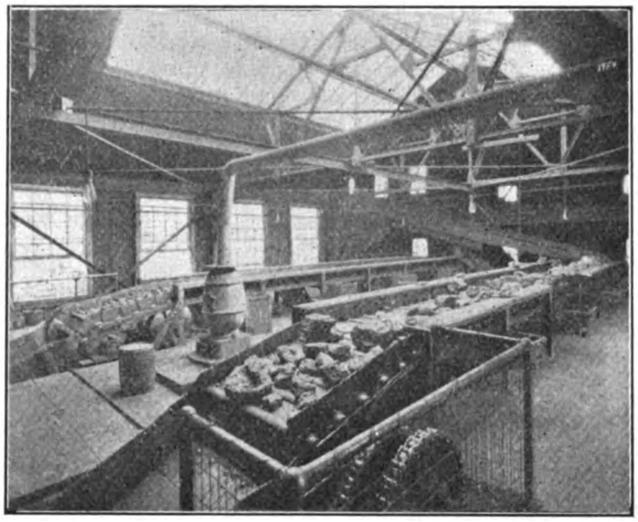
Three-Compartment Double Beaded Conveyor and Picking Table.



Picking House showing Receiving End and Skylights.

Designing

We make complete plans and specifications for both Structure and Equipment, for—Coal Tipples, Coal Washers, Power Plants, Pig Iron Casting Machines, Coaling Stations, etc., and are often retained to make plans and specifications to be submitted to manufacturers for quotations.



Discharge End of Picking Table.

Experience

The Modern Plants Designed, Built and Equipped by us demonstrate our experience. The following are names of customers for whom we have recently done work:

Pocahontas Consolidated Collieries Co., Inc.	Pocahontas, Va.
Houston Collieries Co.	Cincinnati, Ohio
Virginia-Buffalo Coal Co.	Huntington, W. Va.
United Pocahontas Coal Co.	Worth, W. Va.
Borderland Coal Co.	Borderland, W. Va.
Lilley Coal & Coke Co.	South Brownsville, Pa.
LaBelle Coke Company	LaBelle, Pa.
Rum Creek Collieries & By-Product Co.	Dehue, W. Va.
Logan Mining Company	Logan, W. Va.
Rich Creek Coal Co.	Earling, W. Va.
Hutchinson Coal Co.	Fairmont, W. Va.
H. T. Wilson Coal Co.	Logan, W. Va.
Bottom Creek Coal & Coke Co.	Vivian, W. Va.
Island Creek Coal Co.	Holden, W. Va.
Northwestern Iron Co.	Milwaukee, Wis.
Iroquois Iron Co.	Chicago, Ill.
United Iron & Steel Co.	Leetonia, Ohio
Minnesota Steel Co.	Duluth, Minn.
Penn Iron & Coal Co.	Canal Dover, Ohio
Inland Steel Co.	Indiana Harbor, Ind.
United Furnace oC.	Canton, Ohio
Mark Mfg. Co.	Chicago, Ill.

The Morrow Manufacturing Company

WELLSTON, OHIO

Manufacturers and Contracting Engineers

Products

We are designers and builders of

Complete Coal Tipple Equipment;
Steel Tipples;
Independent Steel Frame Shaking Screens;
Plain Shaking Screens, using tne well-known and tried "Morrow Crank Drive;"
Plain and Safety Self Dumping Cages;
Loading Booms;
Conveyors;
Picking Tables, Etc.

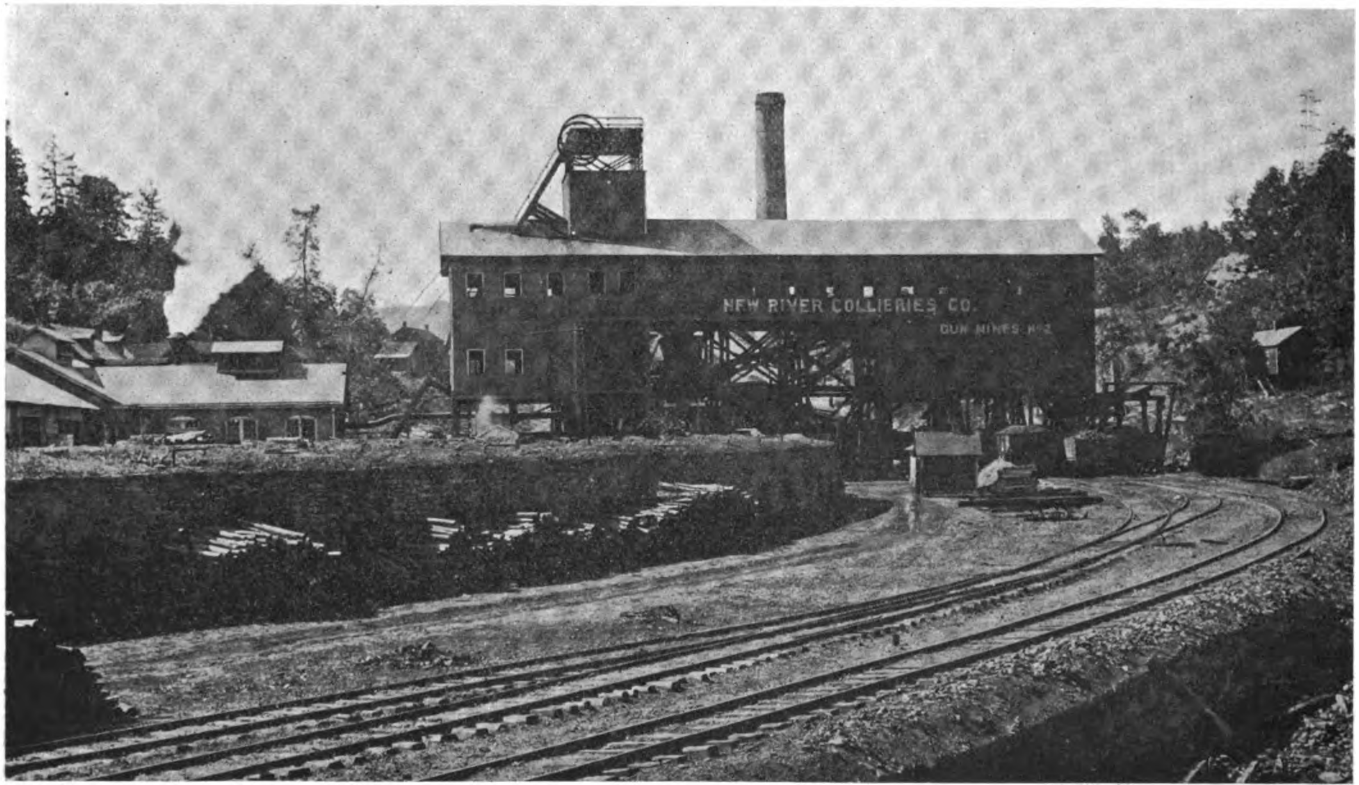
It is quite as important that you purchase the kind of machinery that is best adapted to your needs as it is to buy first-class goods. You can improve the condition of your output and realize a better price for your product through the use of machinery especially designed and built to meet your requirements.

Experience

The President of this Company became identified with the coal business over fifty years ago. During all these years he has followed the industry and has naturally gained a wide experience in all branches of it. This experience which has cost years of labor as well as much money, together with the services of our now more active engineers is placed at the disposal of those desiring to equip their coal tipples in the most practical and satisfactory manner.

Our well-earned reputation of creating original and practical designs, gained through these years of experience in the solution of problems presented in the coal fields of this country, and the handling of our engineering and construction work in such a manner as to thoroughly satisfy our clients, has placed us in a leading position in the coal tipple business.

We are not prejudiced in favor of any particular appliance but always base our selection on the particular requirement.



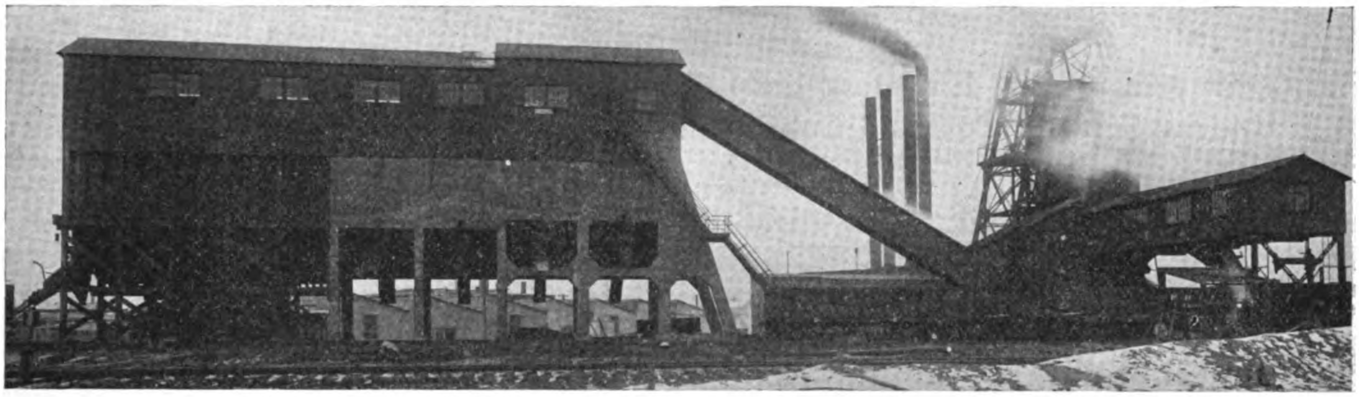
New River Collieries Co. Tipple.

ROBERTS AND SCHAEFER CO.

CHICAGO, U. S. A.

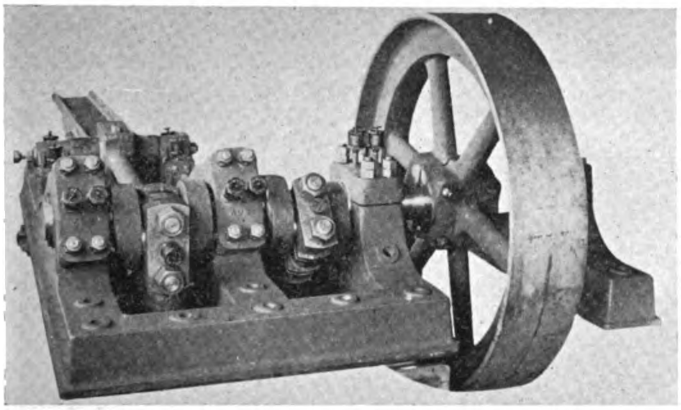
ENGINEERS AND CONTRACTORS

Designers and Builders of Complete Plants for the Economical Handling and Preparation of Coal

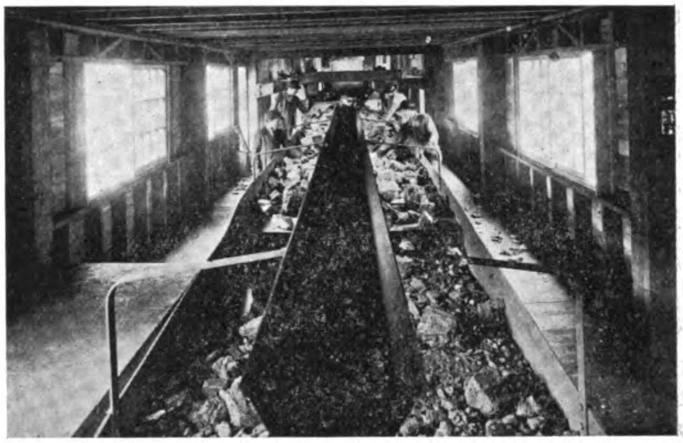


Plant of Springfield District Coal Mining Company, Woodside Mine, Springfield, Illinois.
Capacity of Mine, 2500 Tons a Day.

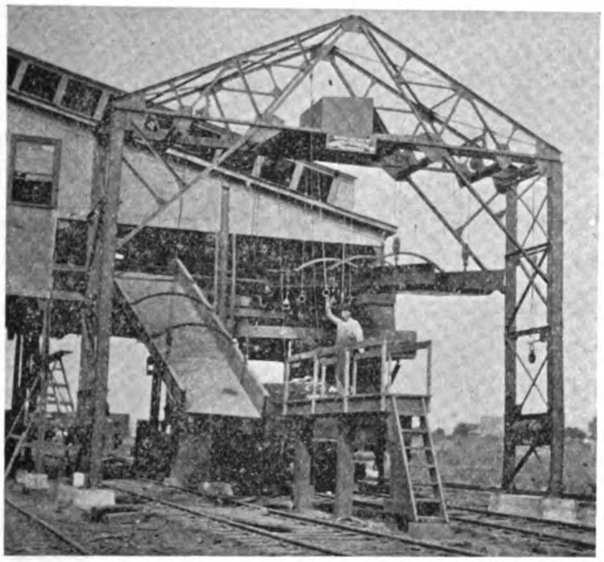
Entire output of mine may be delivered directly to Marcus Screen in tipple, or may be delivered by conveyor to Marcus Screen over storage bins where five sizes of coal are prepared either for local trade or for shipment.



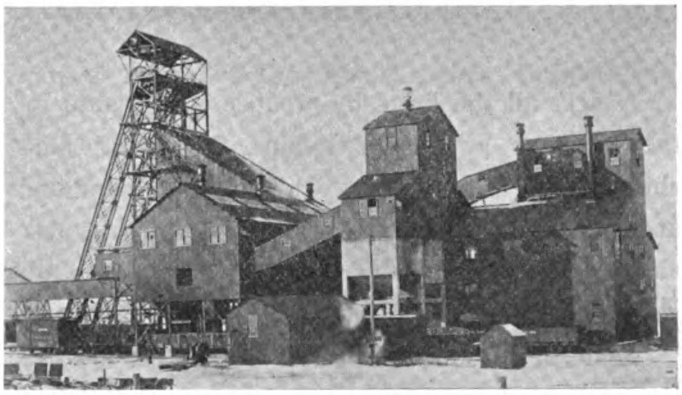
Driving Gear for Marcus Screens are made in four sizes to suit capacity. The illustration shows its ruggedness and strength.



Marcus Horizontal Patent Picking Table Screens save head room, screen coal with minimum degradation and allow picking at extremely low cost for operation, maintenance and repairs.



"RandS" Shaker Loading Booms load coal with minimum breakage, less expensive to buy, also to operate and maintain.



Combined Tipple, Washery and Dryer, Cottonwood Coal Co., Lehigh, Mont., having capacity of 3500 tons per day. Cleans, washes and dries coal with minimum degradation.

"RandS" Coal Washing Plants and all coal handling plants carefully designed to meet particular requirements; therefore obtain best results with less cost for operation and maintenance.

"Coal Conservation" bulletins, issued by us, Contain cost data which will be valuable to you. Write for them.

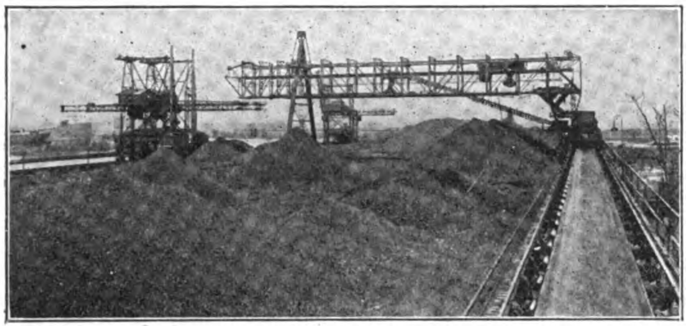
ROBINS CONVEYING BELT CO.

MAIN OFFICE:
13-21 Park Row, New York City
Chicago Office, Old Colony Bldg.
Birmingham, Ala., C. B. Davis Eng. Co.

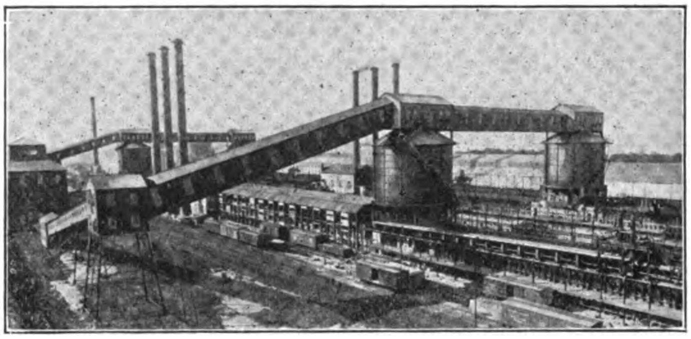
Engineers, Founders and Machinists

Manufacturers of

Belt Conveyors; Bucket Elevators; Unloading, Stocking, and Reclaiming Towers and Bridges; Screens; Coal and Coke Crushers; Castings; Conveyor Auxiliaries

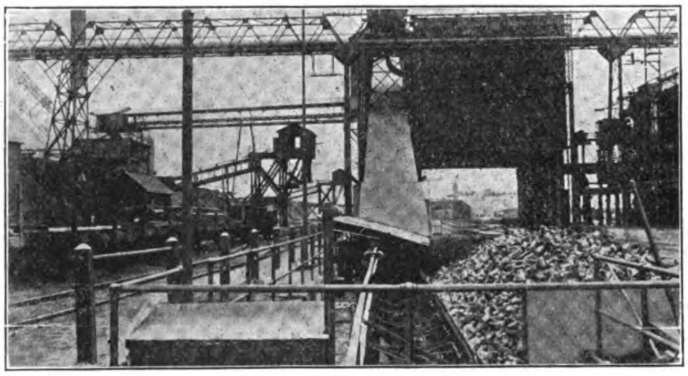


Coal Unloading, Stocking and Reclaiming Equipment.



Robins Conveying System at a By-Product Coke Plant.

Conveyor Carrying Screenings from Tipple to Boiler House.

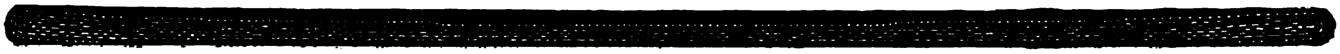


Coke Wharf at a Steel Plant.

Nearly all the large by-product coke plants in this country are using Robins Conveying Machinery, and the auxiliary equipment for handling and screening coal and coke. Our conveying machinery is effecting economies in every kind of work where it is necessary to handle material.

Send for our Illustrated Bulletins describing the Robins System.

We manufacture eight brands of conveyor belts, any one of which, when properly selected, will handle material more economically than the most suitable belt of other manufacture obtainable. Five of the brands are of the stepped ply formation, as shown below, and three are of the straight ply construction. Let us assist you in selecting the proper brand and construction for your work.



Cross Section of "Durabelt" Conveyor Belt.

STEPHENS-ADAMSON MFG. CO.

AURORA, ILLINOIS

BRANCHES

50 Church Street, New York, N. Y.
First National Bank Bldg., Chicago, Ill.
H. W. Oliver Building, Pittsburgh, Pa.
824 Dime Bank Bldg., Detroit, Mich.

803 Federal Reserve Bank Building., St. Louis, Mo.
First National Bank Bldg, Huntington, W. Va.

79 Milk Street, Boston, Mass.
Dooly Block, Salt Lake City, Utah.
310 Stair Bldg. (E. J. Banfield, Agent) Toronto, Ont.

Modern Tipple and Washery Equipment, Coal and Ash Handling Machinery for Power Plants

---

Products

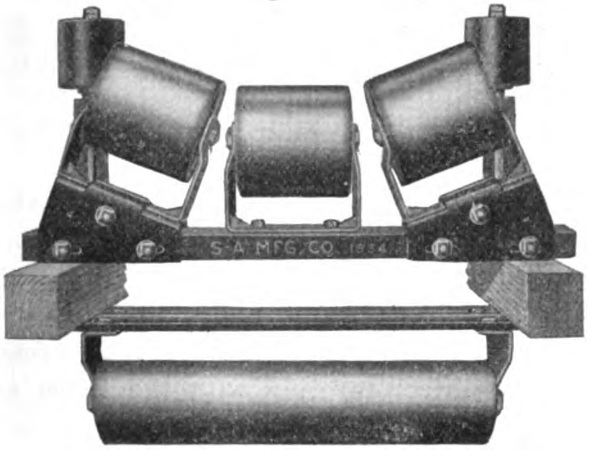
We design and manufacture complete machinery equipment for the handling and preparation of coal, including:

Screening Machinery
- Revolving Screens
- Shaking Screens
- Grizzlies
- Belt Conveyors

Conveying and Elevating Machinery
- Steel Pan Conveyors
- Screw Conveyors
- Pivoted Bucket Carrier
- Gravity Discharge Conveyor-Elevators
- Bucket Elevators
- Automatic Feeders
- Gates, Valves and Spouts

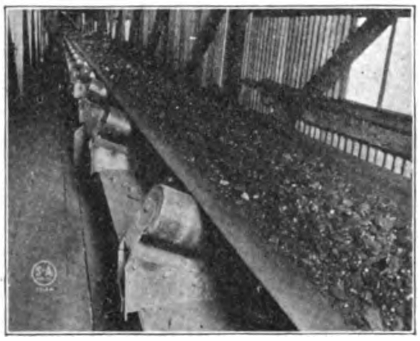
Transmission Machinery
- Shafting
- Bearings
- Pulleys
- Gears
- Friction Clutches
- Rope Transmission Systems

"S-A" Unit Ball Bearing Carriers (Patented).

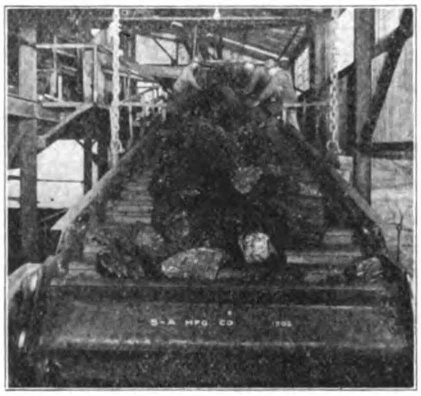


The Unit Carrier for supporting the belts of "S-A" Belt Conveyors is equipped with dust proof ball-bearings. The carrier is entirely of steel construction with rolls of seamless tubing. The advantages of this construction are obvious to engineers. Great strength and durability are secured in the carrier, but the greatest advantages lie in reduced friction, requiring less power and occasioning less wear on the belt. No attention is required by the carrier over periods varying from six months to two years.

Unit Carriers may be equipped with Hyatt Roller Bearings if customer desires.

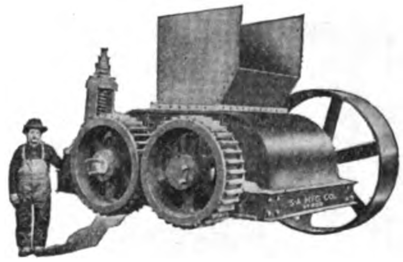


"S-A" Belt Conveyor equipped with Unit Carriers delivering coal to washery in plant of Chicago Wilmington Vermilion Coal Co.



Installation view of Lump Loading Boom in action. This conveyor is pivoted at the center. The upper horizontal section serves as a picking table.

"S-A" Improved Type Coal Crushed, Toggle Spring Release



The floating roll is fitted with our patented toggle spring release, which gives maximum pressure between the rolls when in normal operating condition.

THE WEBSTER M'F'G COMPANY

MANUFACTURERS OF

ELEVATING, CONVEYING AND POWER TRANSMISSION MACHINERY.

Main Office and Works: Tiffin, O.

Branch Offices: Chicago---McCormick Building. New York--90 West Street.

DIRECT REPRESENTATIVES

Philadelphia, Pa.	W. V. Duke, 520 Arch St.
Buffalo, N. Y.	Hancock Engineering Corp., 21 Terrace.
Pittsburgh, Pa.	Dempcy-Degener Co., 307 Fourth Ave.
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Milwaukee, Wis.	William Clasmann, Wells Bldg.
Wilkes-Barre, Pa.	Rudolph Degener, 213 Coal Exchange Bldg.
Atlanta, Ga.	Fulton Supply Co., 86 Marietta, St.
Birmingham, Ala.	G. R. Mueller, Brown-Marx Bldg.
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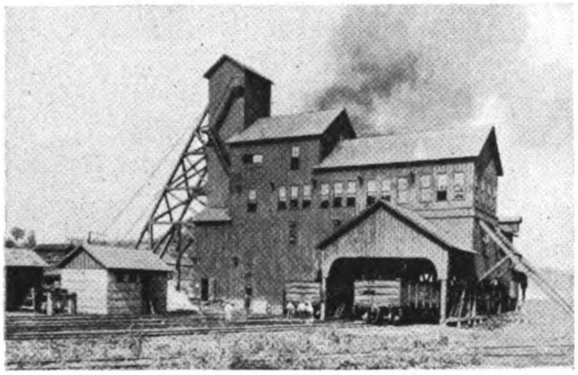
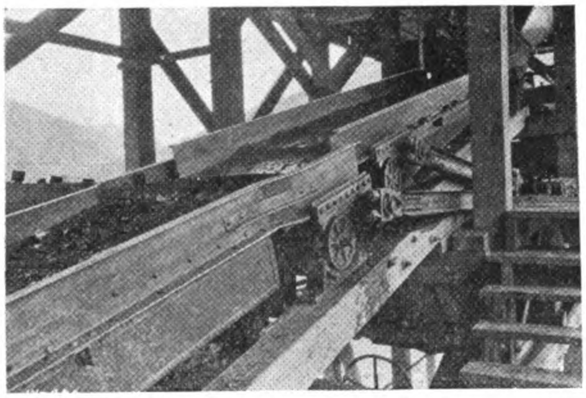


A Complete Tipple.



Shaking Screens Veiled for Mine Run.

Products

Feeders, Crushers, Picking Tables, Loading Booms, Shaking and Rotary Screens.

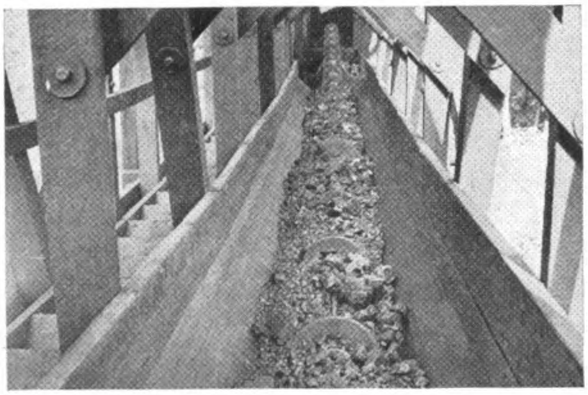
Conveyors, of Cable, Belt, Apron, Flight, Scraper, Screw and other types. Bucket Elevators with Centrifugal or Gravity Discharge Buckets for Vertical or Inclined Lifts.

Pulleys, Gearing, Clutches, Rope, Sheaves, Bearings, Eccentrics—a full line of Power Transmission Machinery.

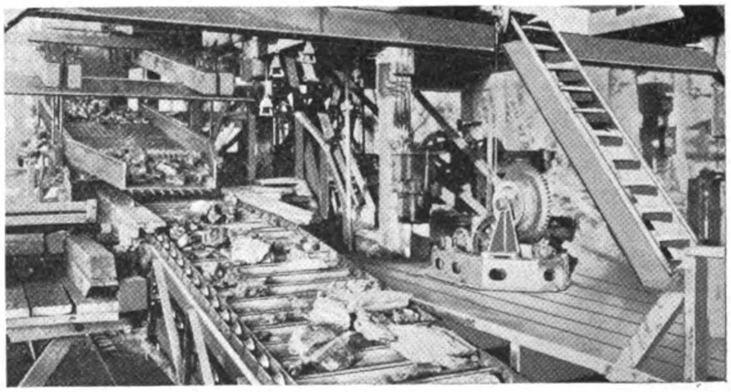
For Mine Operators

The above is but a brief outline of the Webster Products for Coal Tipples. We could not manufacture these successfully unless a thorough understanding of tipple problems and practices enabled us to design each unit to perform its duty efficiently, economically and in perfect harmony with the tipple as a whole.

We design and equip complete tipples and coaling stations, giving to each problem the careful study of engineers whose wide experience insures a design which embodies the best and latest in present day practice as properly adapted to the given conditions.



Cable Type Retarding Conveyor.



Interior of a Webster Equipped Tipple.

WISCONSIN BRIDGE & IRON CO.

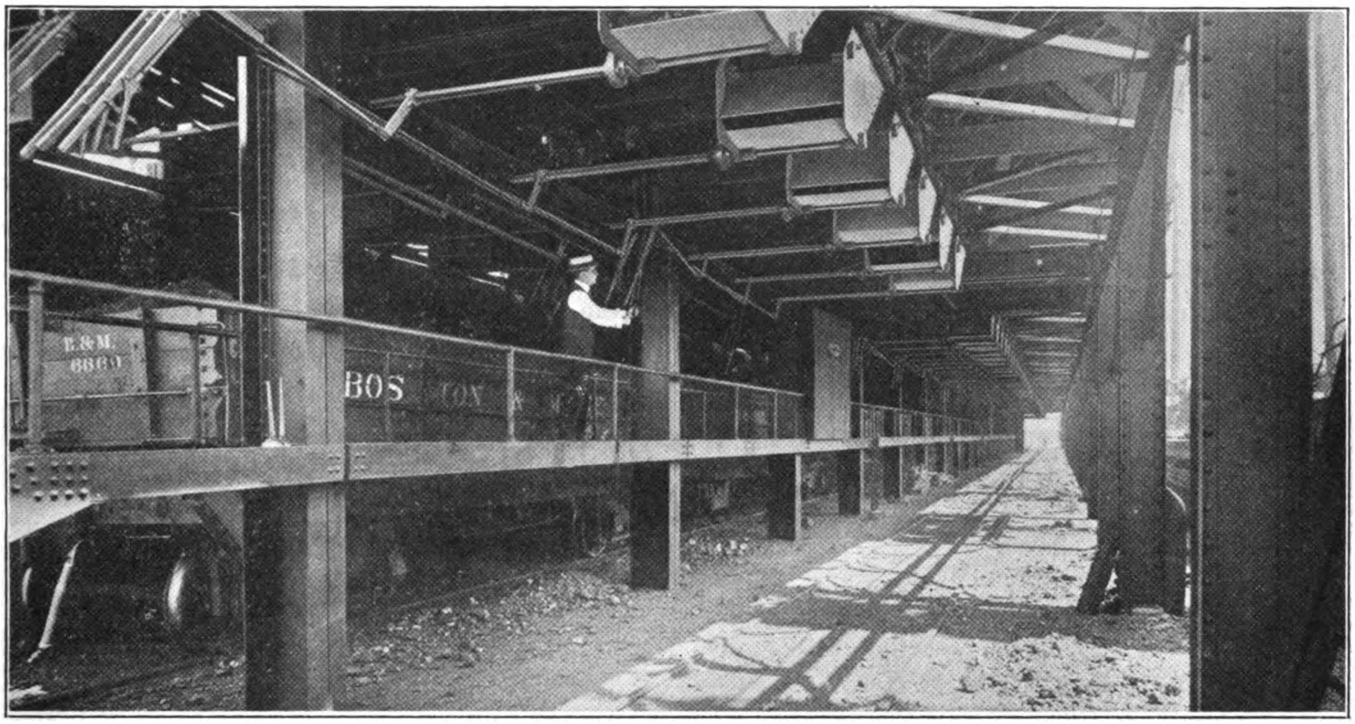
Chicago Office
1619 MONADNOCK BLDG.

Works: NORTH MILWAUKEE, WISCONSIN

Detroit Office
1362 PENOBSCOT BLDG.

DESIGNERS AND BUILDERS OF

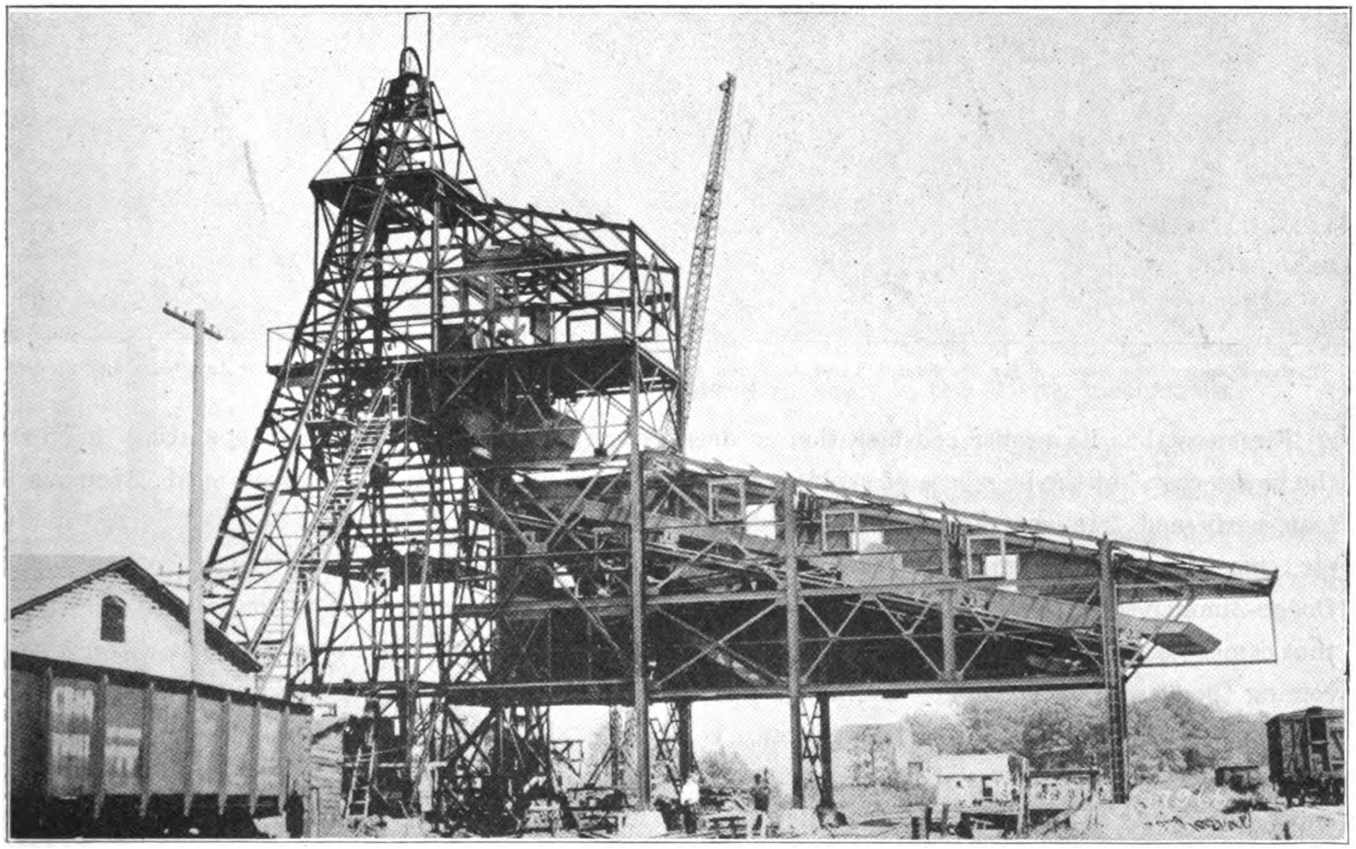
STEEL STRUCTURES FOR HANDLING COAL



Discharge Gates—Darrow-Mann Co.'s Coal Dock, Charlestown, Mass.

The discharging facilities are one of the principal features of this new dock and already have demonstrated what can be done, having loaded 67 cars in 51 minutes, including switching in and out of cars. Two trains of 10 cars each can be loaded in two and a half minutes and this rate of loading can be maintained if necessary.

The gates are operated in sets of six, a center runway serving both tracks as shown in the cut.



Steel Tipple for Earnest Coal Company at Johnston City, Ills.

DODGE SALES & ENGINEERING CO

MISHAWAKA, INDIANA

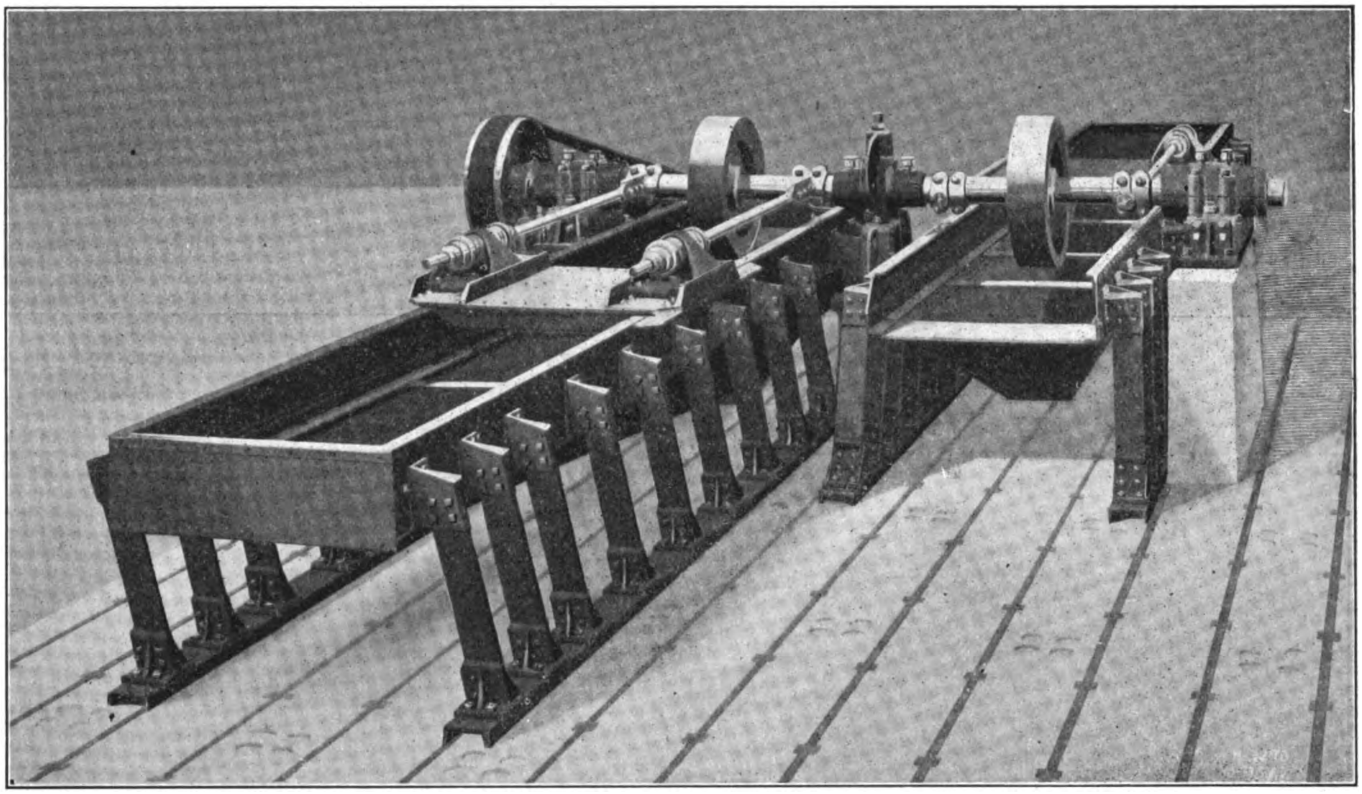
Distributor of the Product of

Dodge Manufacturing Company

Zimmer Conveyors, Screens and Picking Tables

The economical transportation of material is the greatest problem in the manufacturing and mining field, and, notwithstanding the perplexity of the individual case, there is one underlying thought always dominant—the upkeep cost.

First cost has its proper consideration as does the power cost, but the bugaboos of rapid wear and tear, early and frequent replacement, shutdowns, etc., most deeply concern the operator. In the Dodge-Zimmer conveyor we have evolved a system that comes nearer keeping down the cost and overcoming the effects of conveying machinery generally that anything yet placed on the market. The keynote of our new conveyor is simplicity—the short, direct way to efficiency and economy.



Dodge-Zimmer Ore Screens for Rosiclaire Lead & Fluor Spar Company. Set up on the testing floor in the Dodge Shops, Mishawaka, Ind.

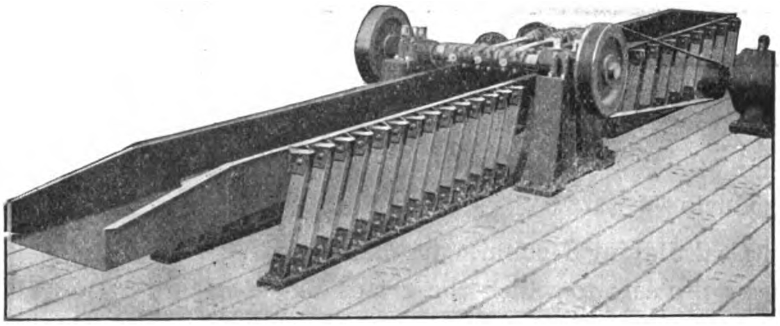
Mechanics tell us that a chain is no stronger than its weakest link. By the same token a conveyor is no more reliable than its weakest part. Chain and link conveyors of various types have been used for many years, particularly in handling coarse substances or when operating in dirty places, where they have proven most expensive in maintenance.

The breakage of any one of a thousand or so parts means disablement not only to the conveyor, but to every dependent part of the works or operations in which it is incorporated.

It also requires double the amount of working chain and parts because of returning strands. This increases the power required, adds to the friction and wears out double the amount of parts really needed to perform the work.

In the Dodge-Zimmer, wherever its use may be recommended by us these annoyances and expenses are minimized. The material travels forward in one continuous stream, without dragging or abrasion and without transporting any of the mechanical parts.

One driving mechanism is employed, the bearings of which, located at one point, alone requiring attention. There is no deterioration of material due to abrasion.



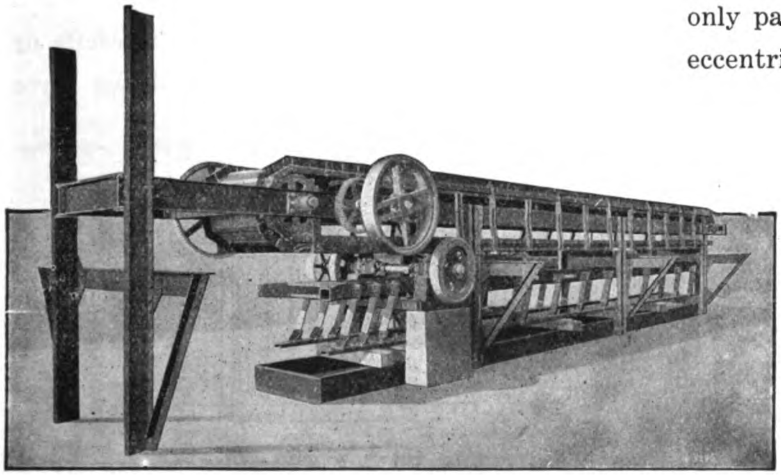
Balanced Type of Dodge-Zimmer Conveyor

Discharge of all of the material may be made at any point or a portion of several points as desired; likewise may the conveyor be fed at one or more points, making a common or divided delivery.

When receiving, conveying or depositing dusty materials, the trough may be inclosed and this prevents loss or nuisance from escaping materials, as is characteristic with other methods.

In certain service where the grading of materials is required, such as coal, stone, etc., the Dodge-Zimmer performs one of its most noteworthy functions by screening or separating and discharging the different grades during the process of transportation. As a cooling or drying apparatus it is a perfect success, and a more effective coal-picking table was never devised.

The Dodge-Zimmer consists of a steel trough of proper depth and width for the capacity required and the material to be conveyed. This trough is supported by or suspended from laminated spring legs. It is attached to the driving mechanism by connecting rods.



In operating the conveyor has a short backward and forward motion, with a slight rise on the forward stroke, which moves the material in the trough in a smoothly floating stream. The material may be screened in transit, and delivery made from the end of the conveyor, or by the use of openings and slides or gates in the bottom.

The advantages of the Dodge-Zimmer summed up are:

(1) SIMPLICITY IN CONSTRUCTION, IN INSTALLATION AND IN OPERATION. The conveyor is assembled and tested at the Dodge shops and shipped in sections so that the installation is simple and inexpensive. In operation the only part that moves on a wearing surface is the eccentric shaft in the driving mechanism.

(2) THE SMALL AMOUNT OF POWER REQUIRED TO OPERATE. A conveyor 12 inches wide and 65 feet long, carrying seven tons of coal per hour, requires 1 brake horse power.

(3) DURABILITY. The few moving parts in this conveyor reduce the wear and tear to a minimum and render cost of maintenance low.

G. H. ELMORE

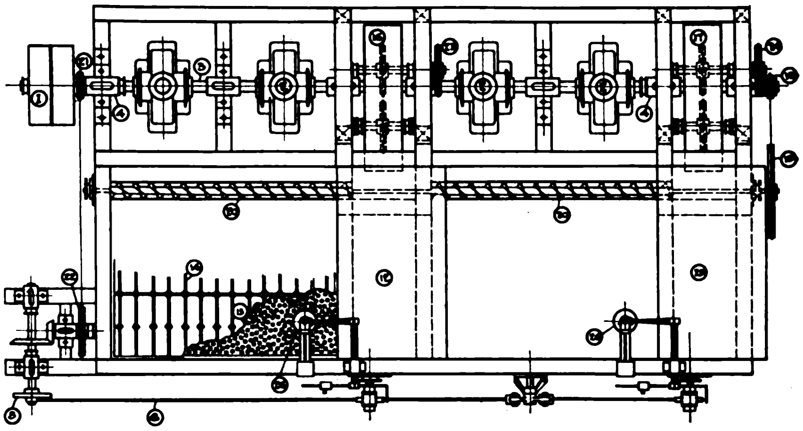
ELMORE PHILADELPHIA SCRANTON ELMORE

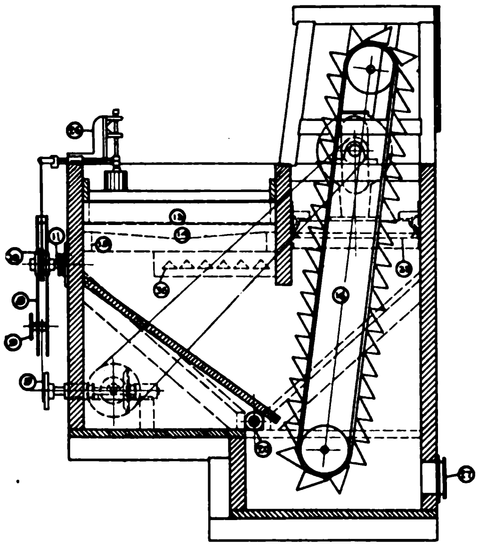
Engineer

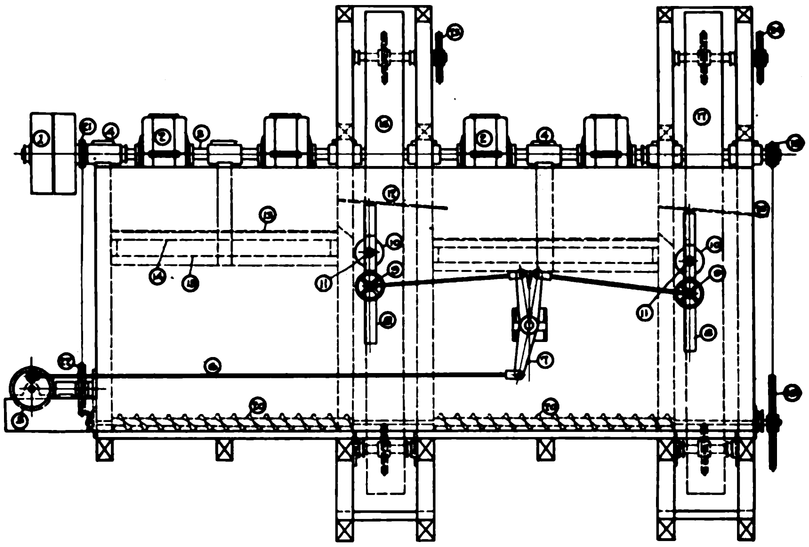
Preparation of Coal

Products

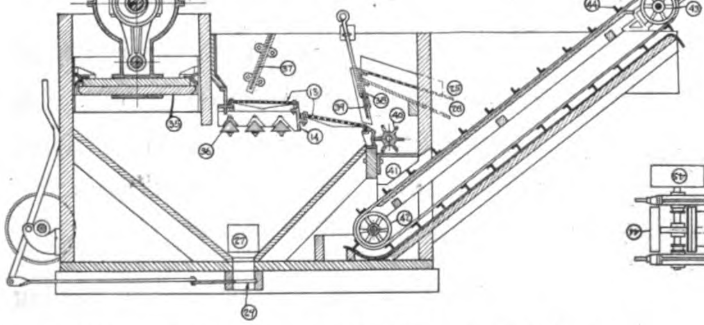
Coal Jigging Machines for handling every problem to which the art of jigging can be applied to coal. To cover the entire field, seven different types of jigging machines are built, four of which are illustrated on these two pages. The equipment embraces machines to handle coal that has been finely crushed preparatory to coking, and in various sizes up to 5½" for either bituminous or anthracite.

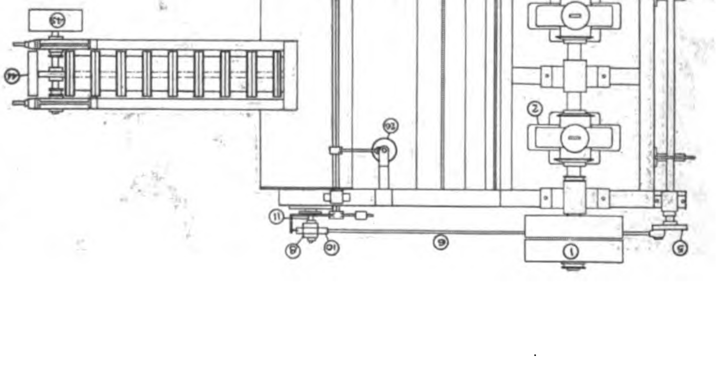

Plan 500-B Two Compartment Jig—Bituminous.

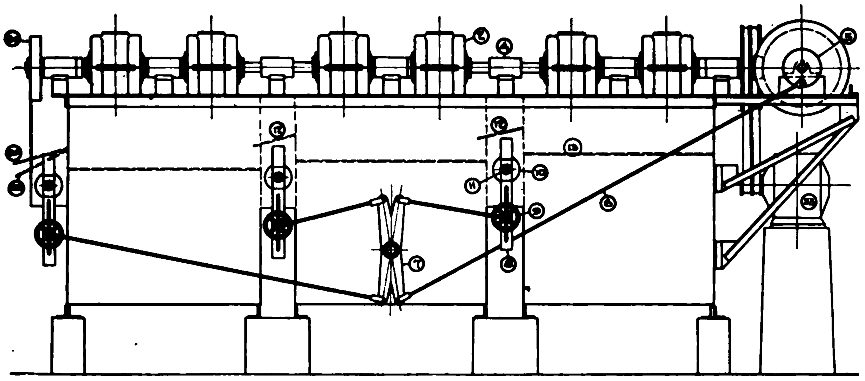

Cross Section Through Elevator Compartment.


Front Elevation 500-B Two Compartment Jig—Bituminous.

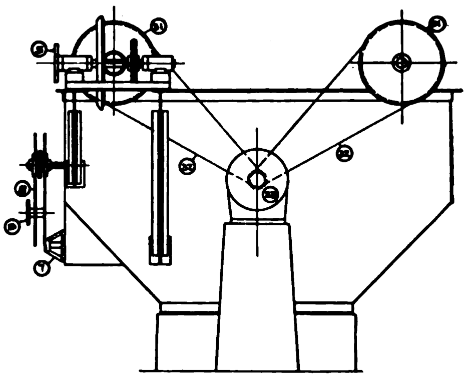
The lower sketches show cross section and plan of the 600-A Jig for either anthracite or bituminous coal. All machines shown have capacities ranging from 40 to 70 tons per hour of feed. The jigging seive is 7 ft. wide and 5 ft. long.



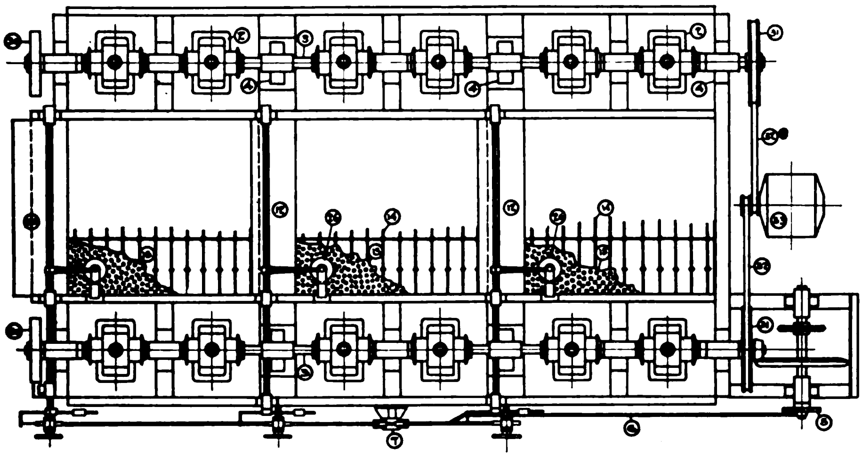




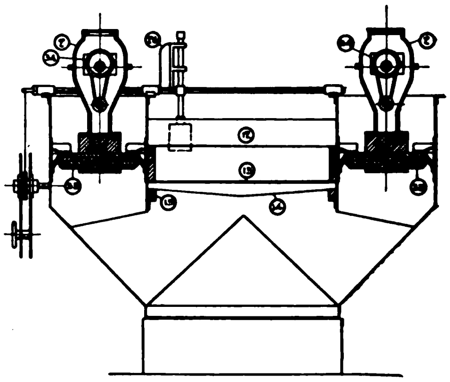
Front Elevation 500 Three Compartment Jig for Coking—Steel Tank.



Head End Showing Double Silent Chain Motor Drive.

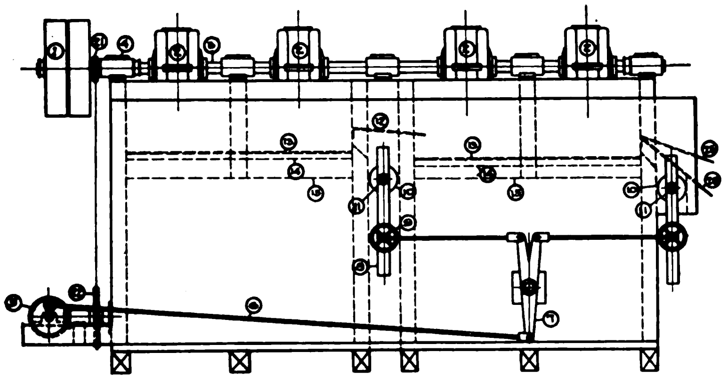


Plan 500 Three Compartment Jig—Steel Tank.

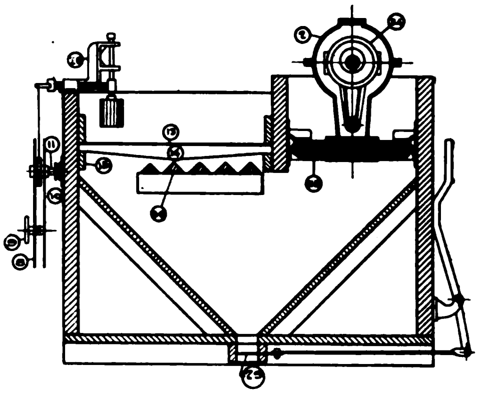


Cross Section.

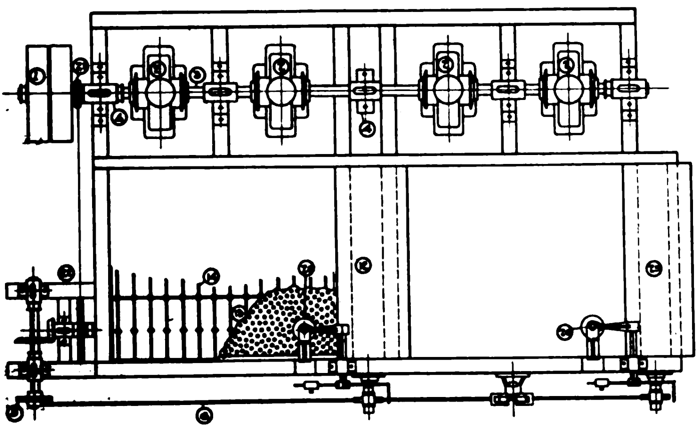
The three sketches below show the 500-A Jig with two compartments, and making a three-part separation of pure slate, pure coal and high ash coal, same as 500-B. This machine is for finely crushed coal, and is fitted with closed type refuse valve, while the 500-B will handle the large sizes, being equipped with open type refuse valve.



Front Elevation 500-A Two Compartment Jig—Bituminous.



Cross Section Through Jigging Compartment.



Plan 500-A Jig—Bituminous.

All machines are equipped with Elmore Automatic Jig Control, the most perfect device ever offered to control the automatic removal of the refuse, and to insure absolutely uniform products of clean coal and clean refuse. These illustrations are taken from a bulletin just published, which covers the whole art of jigging coal, replete with suggestions and valuable data, and describing all machines in detail with particular reference to their adaptability to various problems.

Phillips Mine & Mill Supply Co.

ESTABLISHED 1863.

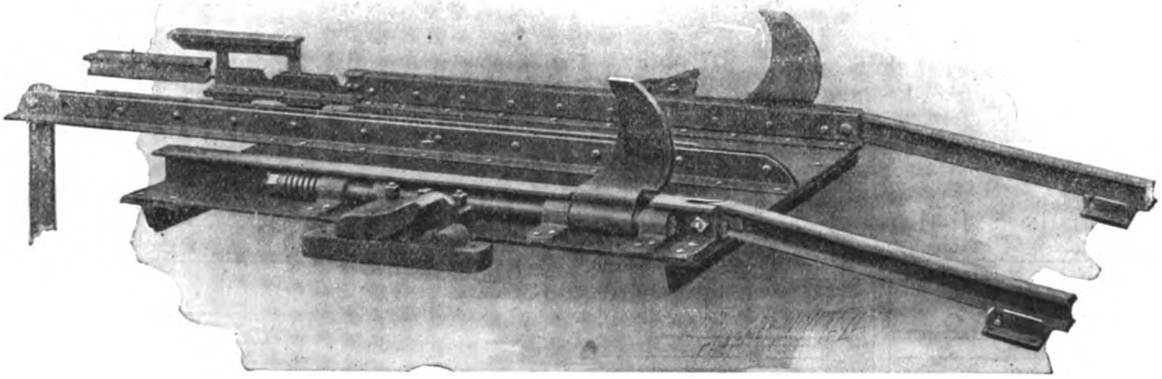
Pittsburgh, Pa.

Mine and Coke Works Equipment

Agencies:
SEATTLE: A. F. Blair, C. & M. E.
HUNTINGTON, W. VA.: MILLER SUPPLY CO.
LETHBRIDGE, CAN.: J. B. Turney & Co.

Products

Mine Cars, Mine Car Wheels, Mine Car Trucks, Screens, Screen Bars, Screening Equipments, Larry Wagons, Cast Iron Frogs and Turnouts, Automatic Car Stops, Caging Machines, the Phillips Automatic Cross-Over Dump, the Phillips Automatic Push-Back Car Dump, etc.



The Phillips Automatic Cross-Over Car Dump

This Dump is so generally known and so widely distributed that it is now recognized as the standard device of its kind, and it is used in all the coal mining fields throughout the United States, Canada and Mexico.

Capacity

The capacity of the Dump is practically unlimited, and it will handle the cars as rapidly as they can be brought to it, a number of operators dumping from 3,000 to 6,000 tons per day over one Dump, at the rate of 5 to 12 cars per minute. We have calculated that if all the Dumps we have installed of this type were run to anywhere near their capacity they could handle with ease the entire coal output of the world.

Construction

The Dump is very substantially constructed to stand rough usage and heavy service, and it can be installed by any carpenter or mechanic from setting plans we furnish. The horn shafts are provided with heavy adjustable buffer springs, which absorb the jar caused by the loaded car striking the horns, thus prolonging the life of the rolling stock, as this feature prevents wheels from being cracked or axles thrown out of alignment. The base of the Dump is a heavy steel plate to which the rails, brake pole and operating mechanism are securely attached.

The construction and price of the Dump varies with the guage of track and weight of the loaded car, and we have built Dumps to handle cars weighing from 2,500 lbs. to 15,000 lbs. loaded. In order to build the Dump and guarantee its operation, or even to quote prices, we always require a drawing of the car which is to be used in connection with it. If more than one style of car is used, a drawing or sketch of each car should be furnished.

We have built most of the up-to-date tipples in Western Pennsylvania, and are always glad to advise on contemplated installations. Your inquiries are solicited.

TAMAQUA MANUFACTURING CO.

Manufacturers of

Improved Machinery for Coal Handling and Preparation

Tamaqua, Penna.

The Tamaqua 1915 Patent Jig for Anthracite and Bituminous Coal

Many of these machines have been successfully installed. They are carefully designed, and well constructed, insuring capacity, efficiency and economy of repairs.

The refuse discharge is automatic and is controlled by adjustments capable of the most sensitive and positive regulation.

The discharge elevators can be extended to any height desired. The drive is by belt or rope from Line or Counter Shaft. When so desired we make the machine direct connected to Engine or Motor.

Anthracite Jig

The accompanying cut represents our 1915 model Anthracite Jig. It is of the reciprocating pan type.

The tank is built of White Pine or Yellow Pine, well constructed and tied together with rods, and is much less liable to strains and leakage than tanks of the plunger type of jigs.

Specifications

Tank: White or Yellow Pine; 8" x 8" sills and caps; 6" x 6" posts; 3" surfaced plank sides, ends and bottom lined with ⅞" W. P. Tongued and grooved flooring.

Pan: Cast iron in one piece, without joints.

Shafting: Machinery steel.

Drive: Pulley or sheave with 10 H. P. Friction Clutch. 7" x 8" Vertical or Horizontal Engine or 10 H. P. Motor direct connected, on special order.

Elevators: Cast iron interlocking buckets for regular specification; steel perfect discharge buckets and all steel chain on special order.

Grates: Cast iron or bronze.

Eccentric Arms: W. I. Forgings with babbitted journal box; W. I. Straps and steel take-up key.

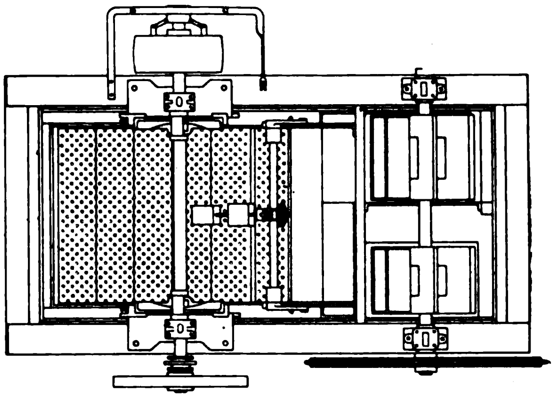
Size of Jig	Capacity Tons per Hr.	Approx. H. P. Con.	Water Gal. per Hr.	Size of Tank			Approx. Shipping Wt. Lbs.
				Length	Heighth	Width	
3 foot	8 to 12	4	300	11' 8"	6' 11¾"	5' 4½"	11,600
4 foot	12 to 16	5	400	11' 8"	6' 11¾"	6' 3 "	13,800

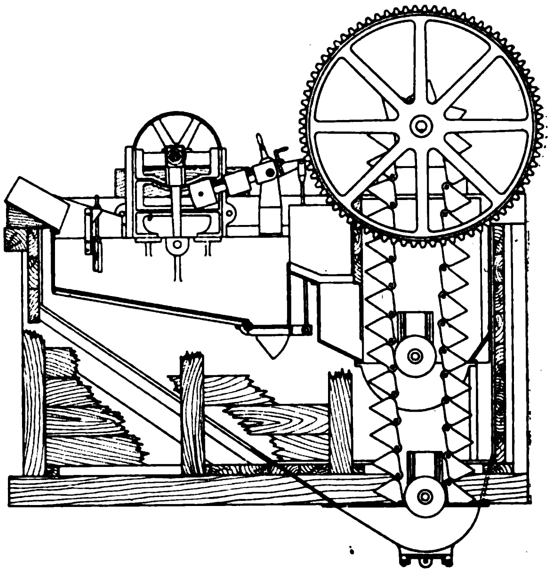
Bituminous Jig Washer

Our Bituminous Jig Washer is a modification of our Anthracite Jig. This machine is provided with a rear elevator for reclaiming fine materials. It is also provided with water circulating arrangement, avoiding the necessity of using pump or settling tank. General specifications are similar to those for our Anthracite Jig.

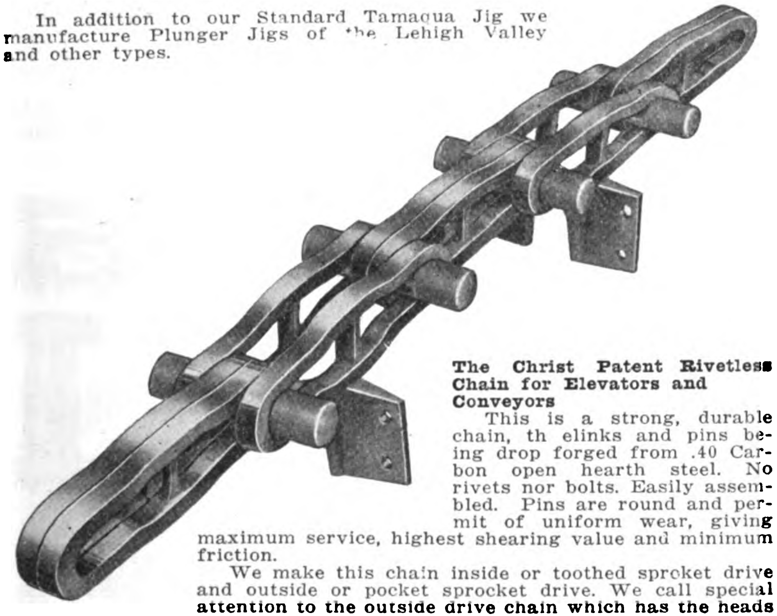
Size of Washer	Capacity Tons per Hr.	Approx. H. P. Con.	Water Gal. per Hr.	Size of Tank			Approx. Shipping Wt. Lbs.
				Length	Width	Heighth	
3 foot	15 to 20	5	450	13' 0"	5' 3"	7' 3"	18,000
4 foot	25 to 30	8	600	14' 6"	6' 3"	7' 3"	20,500

In addition to our Standard Tamaqua Jig we manufacture Plunger Jigs of the Lehigh Valley and other types.





PATENTED



The Christ Patent Rivetless Chain for Elevators and Conveyors

This is a strong, durable chain, th elinks and pins being drop forged from .40 Carbon open hearth steel. No rivets nor bolts. Easily assembled. Pins are round and permit of uniform wear, giving maximum service, highest shearing value and minimum friction.

We make this chain inside or toothed sprocket drive and outside or pocket sprocket drive. We call special attention to the outside drive chain which has the heads of the pins extended to engage in the sprocket. This arrangement avoids the tooth wear on the backs of links, and gives more shearing value as well as less vibration to the chain.

Elevating and Conveying Machinery

We manufacture a line of elevating and Conveying Machinery for light, medium and heavy duty—Riveted or Rivetless All Steel Chain and Malleable Iron Chain.

Crushing Rolls

Steel inserted tooth; manganese segment; open hearth steel segment; chilled tooth cast iron segment, and solid body cast iron.

All sizes. Simple and compound.

Screens

Shaking and revolving screens and screen bars.

Picking Tables, Chute Gates, Car Hauls, Dumps, Etc.

Power Transmission Machinery

We make a line of manilla rope transmission and idler sheaves, belt pulleys, journal boxes, shafting, collars, gearing, tension carriages, etc. This machinery is specially designed for colliery use.

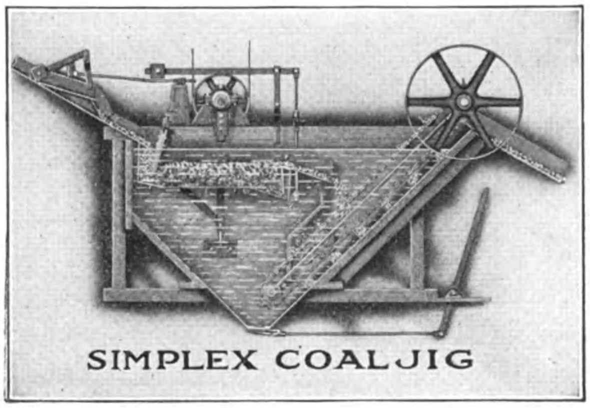
Chain No.	Pitch Ins.	Dia. of Pins Ins.	Width of Outside Links	Width of Inside Links	Breaking Strain. Lbs.	Working Strain Lbs.
144	4½	¾	7/16"	⅞"	48,000	9,600
121	6	1⅛	½"	½"	100,000	20.000
110	6	1⅛	¾"	¾"	106,000	21,200
108	9	⅞	½"	½"	60,000	12,000
107	9	1⅛	¾"	¾"	106,000	20,000

Attachments extra. Above prices subject to discount.

WILMOT ENGINEERING COMPANY

Works: White Haven, Pa. HAZLETON, PA.

Improved Breaker Machinery



For Anthracite Coal.

This Jig is, as its name implies, simple in construction and operation, yet in the performance of its work there is none more efficient and its marvelous capacity is equal to that of larger and higher priced Jigs and the maintenance cost much lower.

The satisfactory performance in the several places it has been installed in the past year has earned for it a very enviable reputation as well as the endorsement of many mining superintendents and engineers of the anthracite coal field.

Lloyd Compound Gear Driven Rolls

Correct speed, and greatest capacity. Perfect mechanical construction throughout. Every emergency provided for.

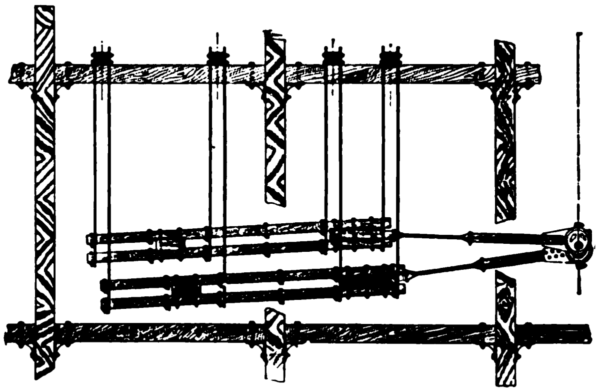
Guarantee

Maximum tonnage in prepared sizes. Minimum loss in breakage. In three sizes:

24" Diam. x 28" Long. 36" Diam. x 46" Long. 36" Diam. x 34" Long.

The Parrish Flexible Arm Shaking Screen

The best type of screen made for use in the coal breaker, soft coal tipples or sand and gravel installations. Less vibration and greatest efficiency of any shaker screen ever used.

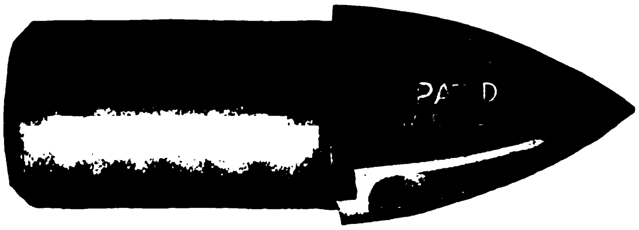


The Parrish Shaker—(Patented)

Lowest installation and operating cost. Simple, strong and durable. Can safely be installed in old breakers.

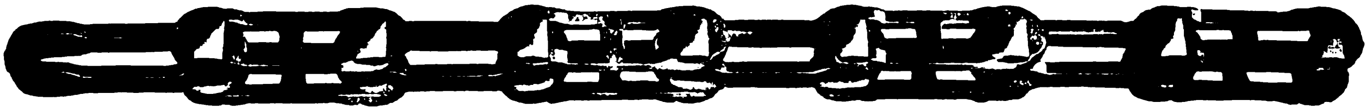
Our Hollow Ground Roll Teeth

These hollow ground roll teeth, made in Drop Forged Steel for the inserted tooth roll and Manganese Steel for the segmental roll, are now being extensively used for the preparation of anthracite coal.

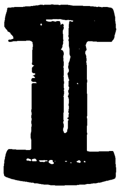


The keen cutting edges, which is the business end of the roll, do the work more efficiently than any other shaped tooth. Made in three sizes.

Try them and be convinced.



Keystone Rivetless Chains



The strongest per cross section area.

The cheapest from service point of view.

The only Rivetless Chain designed and built along straight lines, thus insuring maximum strength and minimum wear and preventing distortion of the links, and change of pitch.

Possesses all the advantages of any other rivetless or riveted chain.

Note the rugged bull-dog construction of the pin-head—a positive guarantee against acid waters, wear and tear.

Made in Drop Forged High Carbon Steel, Manganese Steel and Malleable Iron in sizes as follows:

Pitch	Diam. of Pin	Malleable Iron No.	.40 H. C. S. Drop Forged No.	List Price Per Foot Subject to Discount. Malleable	Drop. Fgd.	Manganese	Weight per Foot	Approximate Breaking Strain
3	⅝	358		.60			5.	16,000
4	⅝	458		1.00		4.00	5.75	20,000
6	1⅛	698		1.20			10.1	42,000
9	1⅛	998		1.16			8.24	42,000
6	⅞		678		1.30		5.92	60,350
6	1⅛		698		2.00	3.50	10.72	100,000
8	1⅛		898		1.80		9.6	100,000
9	1⅛		998		1.60	3.00	8.46	100,000
9	1⅜		9118		3.00		15.7	200,000

WOOD EQUIPMENT CO.

General Offices
McCormick Building
CHICAGO, ILL.
Pittsburgh—Fulton Building
Knoxville—Holston Bank Bldg.

Manufacturing the

Pneumatic Rotary Dump

And Other Mine Equipment Specialties

Products

Pneumatic Rotary Dump—for Drift, Slope, Incline and Shaft Bottom Steel Mine Cars, Car Couplings, Etc.

The Pneumatic Rotary Dump

Is of vital importance just now as one sure means of effecting definite **increase of output,** removing limitation to the handling of the maximum tonnage which can be mined and hauled.

It assures higher grade of product by reducing breakage.

Its reduced labor requirements release men for employment at other duties.

It enables the use of solid-end cars, which are less costly to buy and maintain, and which reduce both track cleaning expense and dust explosion risks.

It eliminates many of the usual dangers of personal injury.

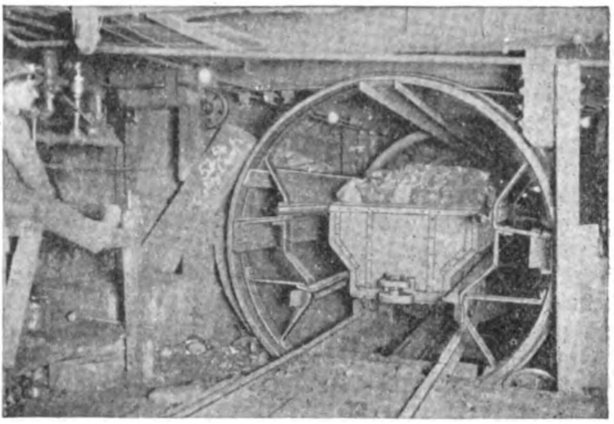
Design, Construction and Operation

These Dumps are operated by Air Cylinders, which are under immediate control of the operator at all points of rotation.

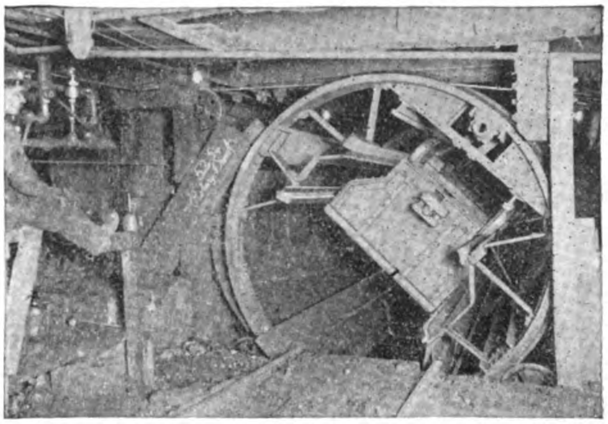
All movements are air-cushioned, eliminating any and all jolts to the car or dump equipment, thus assuring negligible maintenance cost; absolute reliability of operation. Horse Power consumption is very low under ordinary conditions. Can be built to handle any size cars, singly, or in multiples, to give the capacity required.

Six-Car Trip in a Mine Tipple.

Each dump designed to suit the specific conditions under which it shall operate, and built to last the life time of the mine.



Multiple Dump in a Shaft Mine.



Dump Rotated and Car Empty.

The Pneumatic Rotary Dump

Is adaptable to old or new mines of all types, as shown in our several bulletins, which will be sent on request.

No. 170—General Description and Advantages.
No. 171—At the Bottom of the Shaft.
No. 172—At the Head of the Slope.
No. 173—At the Foot of the Incline.
No. 174—Dumping at the Drift Mine Level.

CROSS ENGINEERING COMPANY

Office and Works,
CARBONDALE, PA.
Manufacturers of

Perforated Coal and Coke Screens and Special Coal Preparing Equipment

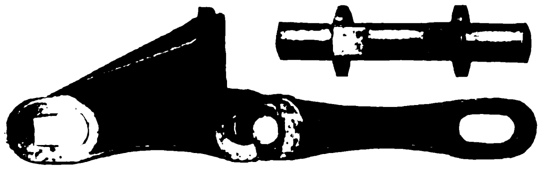
Products

We specialize in the manufacture of Perforated Metals, plain or fabricated, for coal, coke, and stone products operations. We make complete

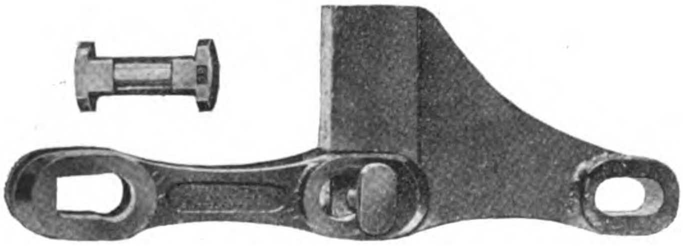
- Plain Screens;
- Shaking Screens;
- Conical Screens;
- Cylindrical Screens;
- Cross Flanged Lip Screens;
- Angle and Grizzly Screens;
- Kerrigan Flat Slate Pickers;
- Plain and Perforated Buckets;
- Trough and Flights;
- Conveyors, Elevators and Casings;
- General Sheet Steel Work.

Simplex Rivetless Chain

The illustrations below show the parts of our Simplex Rivetless Chain,—a positive lock, standardized chain for flight conveyors, bucket elevators, car hauls, and heavy conveyance in general. The pins when inserted and turned into position are positively locked and cannot come loose accidentally. They need no tightening of bolts, once placed they need no further adjustment, and no tools are required in assembling or disconnecting. Links and pins are reversible and interchangeable. Can be operated both center and outside drive.



9-Inch Reinforced Malleable Link with Flight Link and Pin.



9-Inch All Steel Link with Car Dog and Pin.

Strongest chain per cross-sectional area on the market today. Forged steel pins used in all types.

	Breaking Strength.
6-in. pitch, Malleable	33,500 lbs.
6-in. pitch, Forged Steel	50,200 lbs.
9-in. pitch, Reinforced Malleable	62,500 lbs.
9-in. pitch, Forged Steel	90,300 lbs.

Over 85,000 lineal feet in operation.

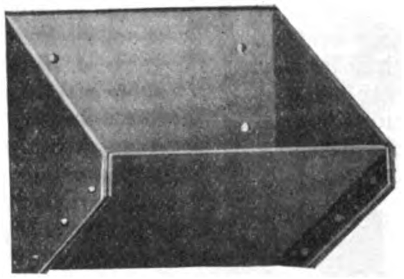
CROSS ENGINEERING CO., CARBONDALE, PA.
CE
PERFORATED SHEET METALS

Screens

We make screens in all metals, with any standard perforations, of any size, as well as special shaped screens for special purposes. Our manganese bronze screens and castings are reputed for quality and durability. Some of the various shapes, with sizes, thickness, capacities, etc., are given in our catalog which may be had for the asking.

Elevator Buckets

We specialize in the manufacture of plain and perforated steel buckets for handling washed coal, slack, ground coal for stoker feed, ashes, etc. Made to specifications in any shape or capacity.



PERFORATED METALS
COAL PREPARING AND MACHINERY
SIMPLEX RIVETLESS CHAIN
CROSS
CROSS ENGINEERING CO.
CARBONDALE, PENNA.

We will replace your old buckets or furnish an elevator complete to suit your requirements.

Ask for this
Catalog

You will find it very convenient in making up specifications.

HENDRICK MANUFACTURING CO.

CARBONDALE, PENNA.

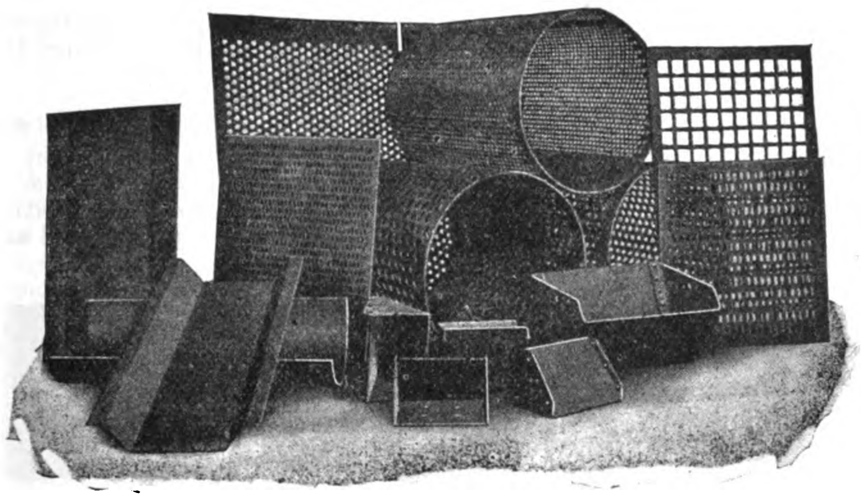
Perforated Metal Screens

Elevator Buckets, Conveyor Flights and Pans.

Products

Perforated Metal Screens in Steel, Bronze, Copper, Brass, Lead, etc., for coal, coke, ore, and other materials requiring screening. Holes round, square or slotted. Sizes to 8" diameter and 6" square, inclusive. Variations in thickness of metal determined by size of perforations.

Plates furnished flat; flanged up or down at ends or sides with bolt holes for attaching to shakers; rolled to diameter or radius for revolving and conical screens.



Elevator Buckets

We are in a position to supply various sizes and styles. Will be pleased to have your orders, or quote on your inquiries, on receipt of blue print, sketch, or sample bucket.

Perforated Elevator Buckets

For Stewart and Luhrig Elevators, or any slush line. As we are perforators of metals we are able to execute orders for this type of bucket in a prompt and satisfactory manner. We receive orders from various companies in the anthracite and bituminous field for large quantities of buckets of this type.

Conveyor Flights and Pans

We make Flights and Pans for Scraper and Apron Conveyors, Picking Tables and Loading Booms. With large hydraulic presses, and numbers of forms we are admirably equipped to handle work of this character. We hope to hear from you.

General Sheet Iron and Structural Dept.

Besides making elevator buckets, flights and pans we fabricate steel work of every description; stacks, tanks, steel mine car buggies, side and bottom sheets for mine cars, bumper bands, steel and wood sides for shakers, elevator links, etc.

Stock of Blank Plates and Sheets

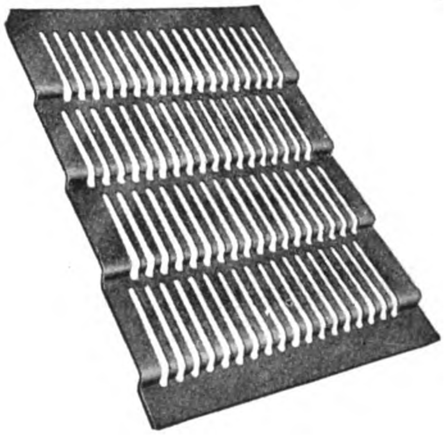
We carry at all times over a thousand tons of ½" to No. 22 U. S. Std. Gauge Steel of standard widths and lengths, enabling us to make prompt deliveries of most orders, and if the material is not in stock we can secure it in a reasonably short time from the mills.

The Flanged Lip Screen

The cut shows our Flanged Lip Screen which is used extensively in the anthracite and bituminous field. This screen is made to serve. If you go into a modern coal preparing plant you will, no doubt, find this screen playing an important part. It may be on the shaking screen, at the loading chutes or as a discharge screen.

TIPPLE BUILDERS recommend this screen.

You will notice that the holes are smaller at the top than the bottom—this feature makes it non-clogging—no raking or pounding required. Increases screening efficiency of bituminous coal 50%.



Also used as a breeze screen for coke, and sizing coal for locomotive stokers.

Write for Circular No. 13.

We hope to receive your orders or will be glad to quote on your inquiries.

"Your product will be clean if you use a 'Hendrick' Screen."

REMALY MANUFACTURING CO., INC.

TAMAQUA, PA.

Manufacturers of

Perforated Sheet Iron Screens of All Descriptions, Elevator Buckets, Cellar Doors and Coal Chutes.

New and Improved U-Dent Shaker Plate

(Patented 1915)

U-Dent Shaker Plate

The features of this Shaker plate which appeal to the practical mine operator are many, among them being features rather different from any other plates for this purpose. This U-Dent Shaker Plate patented during the present year spreads the material to be screened uniformally over the plate instead of permitting part of it to travel over in bulk form. This naturally assists in quicker and more even operation.

The riffles which are a features of the plate impart a rolling movement to the coal and this combined with the spreading features assists the finer sizes to readily work their way through the coarser. By actual test it has been shown that this increases the efficiency fully 35%.

The usual perforated plat of 36" x 72" contains from ⅝ to ¾ of an inch expansion which causes the plate to bag. The "U-Dent" idea, however, takes up this expansion without stretching or destroying the fibre of the metal.

Monel Metal as used for these plates is especially valuable in that it retains its brilliancy and becoming smooth as well as bright allows the material to run over the screen very rapidly.

The "U-Dent" feature retards the movement sufficiently to cause the proper screening action.

The illustration at the bottom of this page shows one of these plates with its riffles and "U-Dent" feature. Mine operators who have installed Monel Metal screens and other articles of this valuable material have found that it gives the greatest satisfaction. Being non-corrodible and having the ability to withstand dampness, gases, etc., without rusting makes it highly valuable for all such purposes.

Chemical Tests on Monel Metal

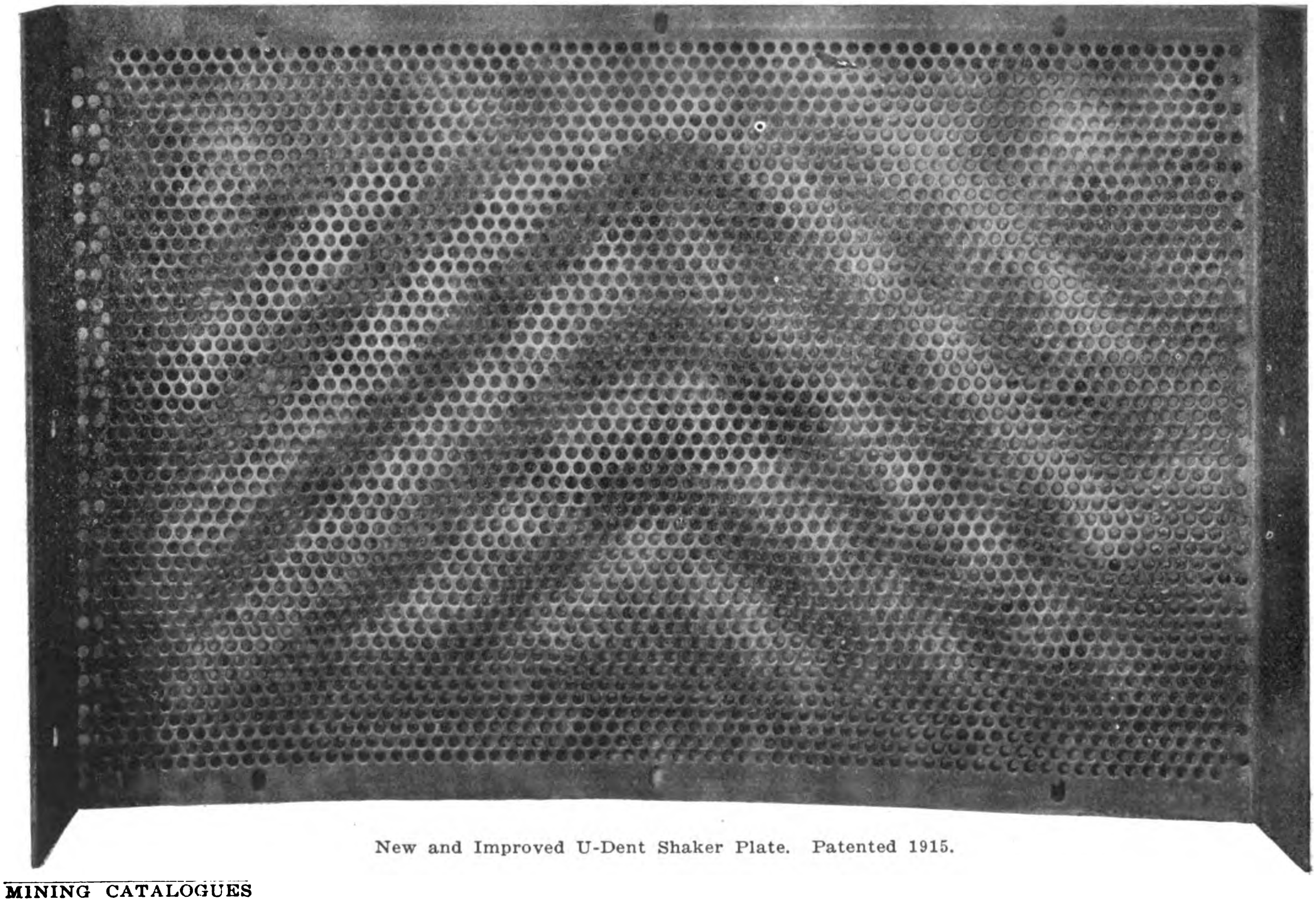
Some very acid mine water was dropped for six days continuously on a plate of Monel Metal and also on a similar one of iron.

This water contained 0.04 per cent. of free sulphuric acid. The iron soon showed the effect of the acid water. The Monel Metal was unaffected, but it was stained by a slight deposit from the evaporated water.

Inquiries

Send us your inquiry with blue print or full specifications (stating whether the plate is flat or flanged) and we will be glad to quote you prices.

We keep a variety of these plates on exhibition in our shops and would be glad to have you call and see them.



New and Improved U-Dent Shaker Plate. Patented 1915.

THE B. F. GOODRICH COMPANY

Factories: Akron, Ohio

Representatives in All Districts.

Conveyor Belts, Elevator Belts, Transmission Belts

Manner of Construction

The type of construction of each belt is varied according to the nature of service required. The Goodrich organization has analyzed the performance of more mining belts in **actual field service** than any other manufacturer. We have combined our knowledge of relative "specifications" with that of **actual performance.** That means good **common sense, practical construction.**

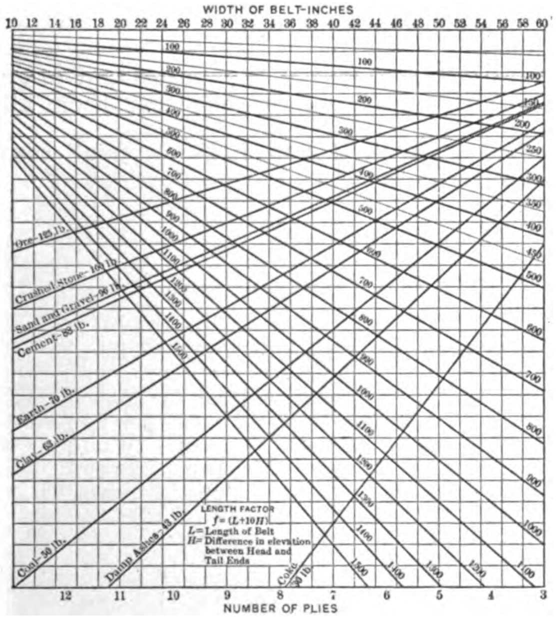
Conveyor Belting

The **Duck**—extraordinary tensile strength, longitudinally; much greater flexibility cross-wise than the ordinary ducks. Our special conveyor duck will trough as easily in the 8-ply weight as another belt in the 6-ply weight.

The **Friction** between the plies is of a good, substantial, elastic rubber. The strong elastic tendrils of rubber hold the plies together; keep their life and vitality during service.

The **Cover**—strong, wear-resisting, tenacious and resilient. Developed to prevent entrance of moisture and resist abrasion by the material handled and injury by blows of the material when delivered to it.

GOODRICH CONVEYOR BELT CALCULATING CHART.



Explanation—Start from the width of the scale at the left, move to the right until the proper length factor line is intersected. Then either up or down until the line corresponding to the material handled is intersected. Then to the right again for the next largest number on the scale indicates the correct number of plies.

If driving pulley is rubber lagged, multiply number of plies by 84-100 or 5-6; if tandem drive, bare pulley by 67-100 or 2-3; if tandem drive lagged, pulley by 55-100 or 11-20.

(Chart is for simple drive bare pulleys).

The **Edge** of our belts stay on until actually worn off. Will not peal off. The one-piece top cover is carried around the edge and into the back, where it is connected. This avoids any tearing point which is made when an extra piece of rubber is added to thicken the cover at the edge. Maximum adhesion at this point. Cured under stretch—no troublesome taking up of the belt when put in service. Runs straight and stays straight.

"Longlife"—an excellent belt for installations where service is continuous and particularly hard.

"Maxecon" for all ordinary service and installations under normal conditions.

Elevator Belts

The Duck—strong and durable. More than ample body for the bucket bolts to grip to securely. An improved friction compound holds plies together and keeps out moisture.

"Goodrich" Brand is of the friction surface type with a double thick gum cushion under the top ply on all sides of the belt. Resists puncturing and moisture either from service, wear or thru the bolt holes. Relieves internal stresses and gives belt more life. Highest quality for heaviest mining elevator work encountered.

"Akron" Brand is rubber covered, but has no gum cushion. An excellent belt for very heavy duty.

"Cost Cutter"—a strong belt for normal conditions.

Transmission Belts

"Commander" Brand — special duck — extra weight and body. Maximum tensile strength and a freedom from stretch without equal. Unusual flexibility. Strong gripping power afforded to fasteners and lacings. Friction of strong adhesion against ply separation. Retains life and protects duck from moisture. Heavy gum cushion under top ply affords special resistance to moisture and unusual degree of flexibility. Friction surface type —special high-grade friction—special heavy duck. Most efficient for extreme of heavy transmission duty.

"Pinnacle" Brand—High-grade heavy service belt. Friction surface type. For driving jaw crushers, crushing rolls. General hard duty.

"Pilgrim" Brand — sturdy belt, plain and stitched, rubber covered type. For normal stresses, ordinary speeds and general operating service.

How to Establish Length of Endless Belt

To twice the distance from center to center of the pulleys add the sum of the diameters of the pulleys in feet, multiplied by 1.57. To this add the difference in the diameter of the pulleys, multiplied by itself and divided by four times the distance from center to center.

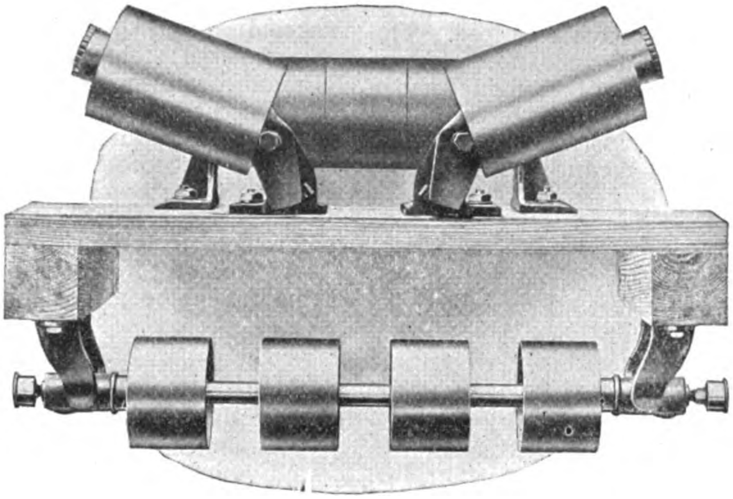
MAIN BELTING COMPANY

Philadelphia, Pa.

NEW YORK, PITTSBURGH, CHICAGO, ATLANTA, SAN FRANCISCO

Main Belting Company of Canada, Ltd.,
Montreal Toronto

Leviathan and Anaconda Belting



Main Adjustable Conveyor Rollers

Built By a Belt Maker to Give the Belt a Chance

Main Conveyor Rollers are built to give the longest possible **belt** life.

Wear due to the material carried is to be expected, but the rollers should not add to the difficulty.

Ordinary rollers often cause more belt wear in **one month** than the material handled does in **six.**

It has taken a belt maker to design rollers that really give the belt a chance.

Main Conveyor Rollers are **adjustable** with reasonable troughing angles and without gaps at the troughing points. Perfectly lubricated bearings make binding impossible.

Every one of these points is important in getting **belt service,** and no other roller has them all.

Conveyor Book 2 will help on your conveyor problem—ask for it.

CONVEYOR CAPACITY TABLES

Belt Troughed at 20 Degrees, with Material Fed Steadily.

Belt Width in Inches	Max. Size of Material	Max. Belt Speed in Ft. per Minute	Uusual Belt Speed in Ft. per Minute	CAPACITY AT 100 FEET PER MINUTE						
				Cu. Ft. per Hour	Bushels per Hour	Tons per Hour for Material Weighing "W" Pounds per Cubic Foot				
						W=50	W=60	W=80	W=100	**W=150**
12	2	300	200	390	310	10	11	15	19	**29**
14	3	300	200	530	420	13	15	21	26	**39**
16	4	300	200	690	550	17	20	27	34	**51**
18	5	350	200	970	780	24	29	39	49	**74**
20	6	350	250	1200	960	30	36	48	60	**90**
22	7	400	250	1450	1160	36	44	58	73	**110**
24	8	400	250	1730	1380	43	52	69	86	**129**
26	9	450	300	2000	1620	50	60	80	100	**150**
28	10	450	300	2350	1880	59	71	94	118	**177**
30	12	450	300	2700	2160	68	81	118	135	**203**
32	12	500	350	3070	2460	77	92	123	154	**231**
34	14	500	350	3480	2770	87	104	139	174	**261**
36	14	500	350	3900	3120	98	117	156	195	**293**
42	18	500	350	5300	4200	132	158	211	264	**396**
48	20	500	350	6900	5500	172	207	276	345	**518**

THE JEFFREY MANUFACTURING COMPANY

Main Office and Works: 962 North Fourth St., Columbus, Ohio

SALES OFFICES:

New York.............50 Dey Street
Boston..............141 Milk Street
Philadelphia.Real Estate Trust Bldg.
Pittsburgh......Farmers Bank Bldg.
Scranton, Pa..Union Nat. Bank Bldg.
Broadwell, O.......H. H. Townsend
Middlesboro, Ky..Middlesboro Hotel
Charleston............West Virginia
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Chicago............McCormick Bldg.
St. Louis...Railway Exchange Bldg.
Milwaukee............M. & M. Bldg.
Denver....First National Bank Bldg.
Seattle............L. C. Smith Bldg.
Birmingham......Brown-Marx Bldg.
Dallas..........................
..Commonwealth Nat. Bank Bldg.
Canadian Works...........Montreal

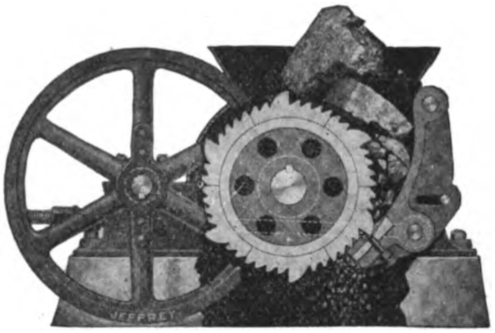
Single Roll Coal Crusher For Sizing Coal For Stoker Use

One operation reduces large lumps and run-of-mine coal to 1¼" and under, the proved size for stoker use.

Receives coal in any volume direct from a track hopper, grab bucket or mine car without the use of a Feeder.

Easily Adjusted. In five minutes, without shutting off the power, the sizes of product can be changed from 7 inches to 1¼ inches.

Can be started up under full load—cannot be flooded or choked down. Equipped with an efficient Safety Device which protects against shocks and accidents.



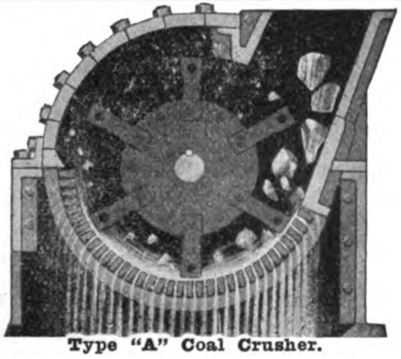
Consumes but little power—costs little to install.

Table of Capacities			Using Hard Bituminous Coal Such as Indiana Block							Using Medium Bituminous Coal Such as Ohio or Illinois Run-of-Mine							Using Soft Bituminous Coal Such as Pocahontas						
Size Crusher Inches	Drum R. P. M.	Appr'x H. P. †	*Size of Product—Tons per Hr.							*Size of Product—Tons per Hr.							*Size of Product—Tons per Hr.						
			1"	1¼"	1½"	2"	2½"	3"	4"	1"	1¼"	1½"	2"	2½"	3"	4"	1"	1¼"	1½"	2"	2½"	3"	4"
18 x 18	75	15	20	25	30	40	....	....	....	30	35	40	45	....	....	....	50	50	50	50	....	....	....
24 x 24	60	30	30	35	45	60	75	90	....	50	60	70	80	90	100	....	100	110	115	120	120	120	....
30 x 30	50	40	50	50	60	80	100	120	160	75	85	100	125	150	170	180	160	170	180	190	200	200	200
36 x 36	40	60	75	80	100	110	130	150	175	100	115	125	150	175	200	200	175	200	225	250	250	250	250

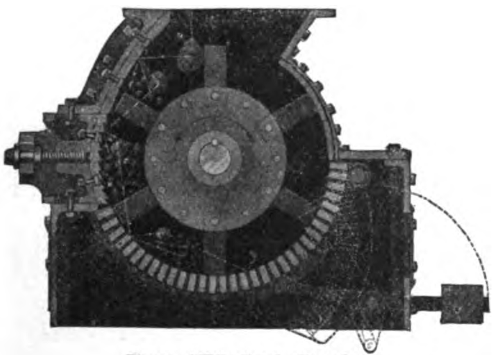
*By "Size of Product" is meant average results, 80 to 90 per cent. pass screen indicated.
†Horse power will vary according to exact nature of coal as to hardness, toughness, friability and moisture.

Size Inches	Shipping Weight, Pounds	Largest Lump for Feed, inches	Max. Speed (R. P. M.)		Size Pulley Inches	
			Roll	Pulley	Dia.	Face
18x18	3200	8	125	500	34	6½
24x24	6500	14	100	400	42	8½
30x30	10500	20	75	300	48	10½
36x36	20000	20	60	240	60	12½

More than 200 Jeffrey Single Roll Crushers are now in use and doing everything we claim for them. Write for Bulletin No. 141-62, containing Illustrations, Detail Drawings, Descriptions and Testimonials.



Type "A" Coal Crusher.



Type "B" Coal Crusher.

Swing Hammer Crushers for Reducing Coal for Coking Purposes

Combine distinctive features in design and construction that insure uniform fineness, the most essential requirement in making good coke.

Type A Crusher

is also particularly adapted for the reduction of refuse or Culm, for flushing back into the mines by water.

Wide openings between the screen bars of Type B Crushers prevent clogging the machine when pulverizing wet coal, cause minimum wear on hammers and allow small pieces of iron to pass through without dropping bottom or stopping the machine. .Write for Bulletin No. 147-62.

Type "A" Coal Crusher

No.	Dia.	Wid.	Approx. H. P.	Approx. Weight Lbs.	Speed.	Approx. Capacity per Hour.
B 2	30"	24"	35	4300	1100 to 1200	20 to 25 tons Run Mine Coal ¼" to Dust
B 3	36"	30"	70	7300	1000 to 1100	50 to 60 tons " " " " "
B 6	42"	24"	70	8000	900 to 1000	50 to 60 tons " " " " "
B 4	42"	36"	80	9000	900 to 1000	70 to 75 tons " " " " "
B 5	42"	48"	110	16000	800 to 900	90 to 100 tons " " " " "

Type "B" Coal Crusher

Code	No.	Dia.	Wid.	Pulley	Approx. H. P.	Aprx Wt. Lbs.	Speed	Floor Space	Feed Opening	Approx. Cap'y Run Mine Coal ¼" to Dust pr hr
Cruknife........	H 2	24"	20"	12"x10"	15 to 18	4000	1200 to 1400	5' 9 "x3' 4¾"	15"x20"	8 to 10 tons
Crudish..........	H 3	36"	24"	22"x15"	50 to 60	9600	900 to 1100	7' 9½"x4' 8½"	22"x24"	50 to 60 tons
Cruspoon........	H 6	36"	42"	24"x24"	90 to 100	11000	800 to 1000	10' x4' 8½"	22"x42"	90 to 100 tons
Cruladle.........	H 7	36"	48"	24"x24"	140 to 150	15000	800 to 1000	10' 7 "x4' 8½"	22"x48"	150 tons
Crublade.........	H 8	42"	60"	26"x28"	225 to 250	30000	700 to 900	15' 4 "x5' 8 "	20"x60"	250 tons

K-B PULVERIZER COMPANY, Inc.

86 WORTH STREET, NEW YORK

Manufacturers of

The K-B Pulverizer

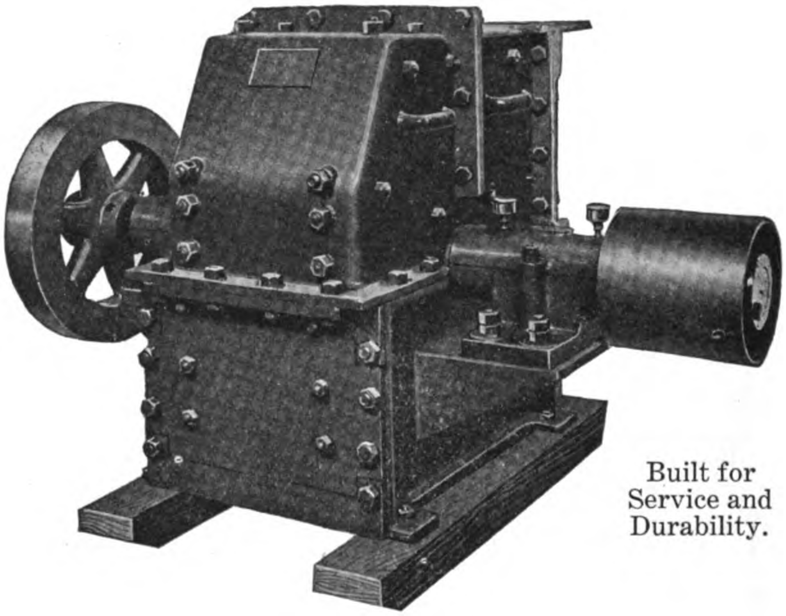
Complete Equipment for Crushing Plants

Jaw Crushers; Magnetic Separators; Screens; Elevators;

The K-B Pulverizer is especially well suited for crushing culm for flushing back in the mines. Its rugged **all steel** frame will withstand the most severe and exacting service, and the entire machine is exceptionally durable.

By the use of fine screens and adjusting the hammers close to the breaking blocks a very fine product can be obtained when crushing limestone, etc., which product is well suited for use in mine for accident prevention. See Technical Paper 84, Bureau of Mines, **"Method of Preventing and Limiting Explosions in Coal Mines."** Also note:

> "Experiments made with machines developed by the Bureau of Mines for Spreading Rock Dust, have shown that by spreading a layer of rock dust over the coal dust in bituminous coal mines the risk of dust explosions is reduced. In the first experiments with rock dust finely pulverized limestone was used, 75 per cent. passing a 100-mesh sieve. Later experiments showed that rock ground by a hammer chusher sufficiently fine to pass a 1/16-in. slotted screen was practically as efficient as the fine dust and much less costly to prepare."—**Engineering News, Vol. 75, No. 24.**



Built for Service and Durability.

Frame

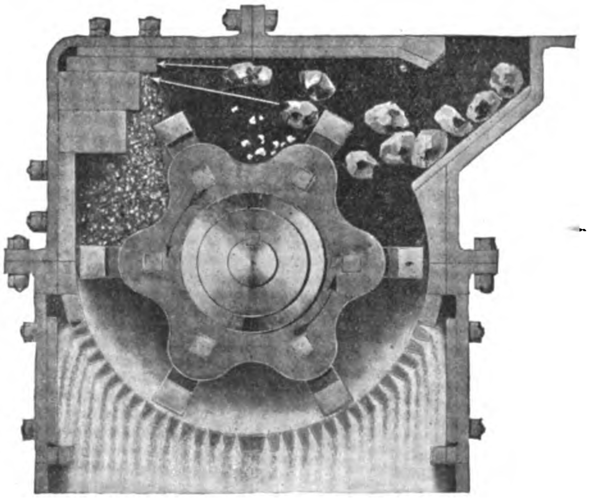
The frame is completely protected by Manganese Steel Lining Plates which insure long wear and can be readily replaced when necessary.

U Type Hammers

—reduce power consumption by concentrating weight at point of impact with incoming material.

Patent Hammer Adjustment

—takes up wear; increases hammer life; maintains capacity; insures uniform product.



Screens

—can be adjusted for any size product and can be changed without difficulty in a few minutes by one man.

Table of Capacity and Power

This table can give only approximate figures, as they vary considerably according to the hardness of the material, its moisture, size of feed, etc.

If you will send us a small sample of your material we will gladly give you more exact figures.

Dimensions of larger sizes of K-B Pulverizer suitable for crushing coal and for coke oven work submitted on request.

	Approximate Capacity			Approximate Power
	Size of Product			
	¼"	10 mesh	20 mesh	
K-B No. 1	Tons per Hour	Tons per Hour	Tons per Hour	
Stone	5-8	4-7	3-6	12-15 H. P.
Coal	7-10	6-9	4-7	12-15 H. P.
Lime	11-15	10-14	7-10	12-15 H. P.
K-B No. 2				
Stone	14-17	13-16	8-12	25-30 H. P.
Coal	18-21	17-20	13-16	25-30 H. P.
Lime	22-27	20-25	15-20	25-30 H. P.

We can also supply Crushing Rolls, Jaw Crushers, and Magnetic Separators for various purposes.

PENNSYLVANIA CRUSHER CO.

Stephen Girard Building, PHILADELPHIA, PA.

NEW YORK
Hudson Terminal Bldg.

PITTSBURGH
Peoples Bank Bldg.

Products

Coal crushing and cleaning machinery for By-Product and Bee-Hive coke plants, Swing Hammer Crushers, Bradford Coal Cleaners, Rotary and Jaw crushers, Single Roll crushers, Grinding Pans, Delamater "sink and float" Testers.

"Pennsylvania" Swing-Hammer Crushers

Extensively used for pulverizing bituminous coals in By-Product and Bee-Hive coking plants, for crushing Cement Rocks and Limestones in Cement Mills, for Lime, Shales, Bone and a multitude of other materials.

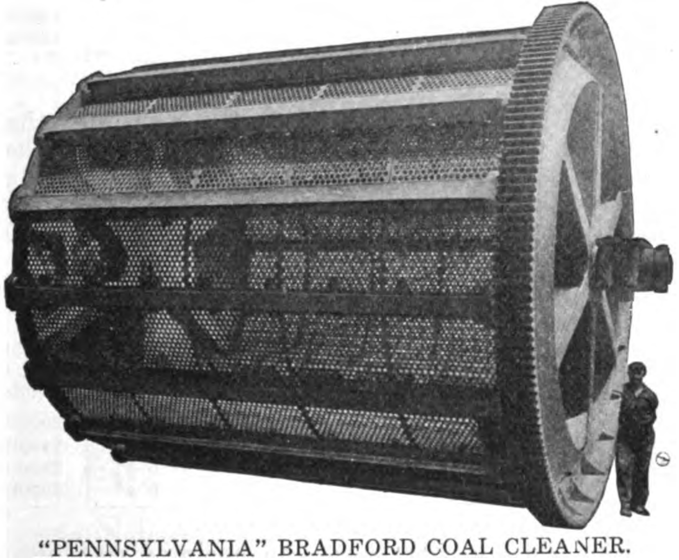
Main frame of fabricated Steel practically immune from breakage. Removable Steel Wear-Liners, Ball & Socket Bearings, 6,8 and 10 rows of hammers, large diameter Steel discs, quick adjustable Grinding Cage. Built in capacities 3 tons to 500 tons hourly. By weight the "Pennsylvania" is more than 90% Steel. Also builders of the only **One-piece** Cast Iron Frame on the market.

"Pennsylvania" Bradford Coal Cleaners.
(For Coke Ovens, Coal Washeries and Power Plants.)

In addition to its distinct advantage as a Crusher, this machine has the **remarkable ability to automatically remove impurities** such as slate, bone, sulphur balls or binder from bituminous steam and coking coals, thereby reducing the objectionable ash and sulphur.

It is used extensively in preparing R. O. M. coals in By-Product and Be-Hive Ovens, Coal Washeries, etc.

In addition to its crushing and cleaning functions for R. O. M. coal for **large Power Houses**, the "Pennsylvania" Bradford is most efficient in removing stray iron, coupling pins, mine props and all sorts of impedimenta that damage conveyors, stokers and other power house machinery.

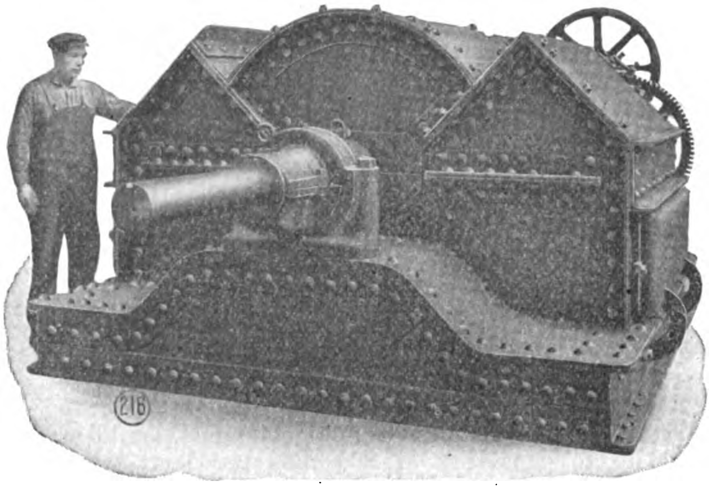


"PENNSYLVANIA" BRADFORD COAL CLEANER.
(Patented.)

For Coal Washeries and Stoker-feed it crushes R. O. M. with less fines than rolls or any other type.

Absolutely automatic in operation, low horse-power, runs 12 to 15 r. p. m., requires no labor to operate, other than occasional oiling. Is practically "foolproof." Built in capacities 10 to 300 tons hourly.

These "Pennsylvania" Bradfords are successfully operating in connection with Coal Washers.



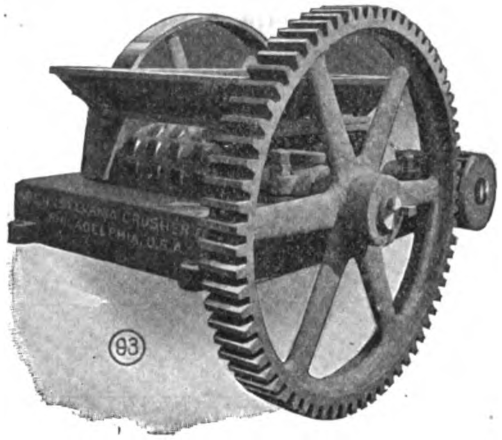
"PENNSYLVANIA" HAMMER CRUSHER.
(Patented.)

"Pennsylvania" Single Roll Crushers

For coarse and moderately fine crushing of coal, coke, lime, limestone, fireclays, shales, phosphate rock, chemicals, etc. **Excellent for stoker-feed crushing.**

Features:

1—Big reduction of large lumps in ONE operation.
2—Fed from bin, car, grab-bucket or steam shovel—no mechanical feeder.
3—Not choked by overfeed—different from 2-roll crusher.
4—Roll won't spread, no matter how heavily fed.



ROLL CRUSHER.

5—Can be started with hopper full.
6—Automatic safety device.
7—Readily adjustable for varying sizes of crushing.
8—Wear parts quickly accessible.
9—Slow speed—35 to 40 R. P. M.
10—Easy on horse power.
11—Several sizes, ruggedly built, simple design.
12—Very economical of headroom.
13—Low upkeep and installation.
14—No changing pitch diameters.

THE WILLIAMS PATENT CRUSHER AND PULVERIZER CO.

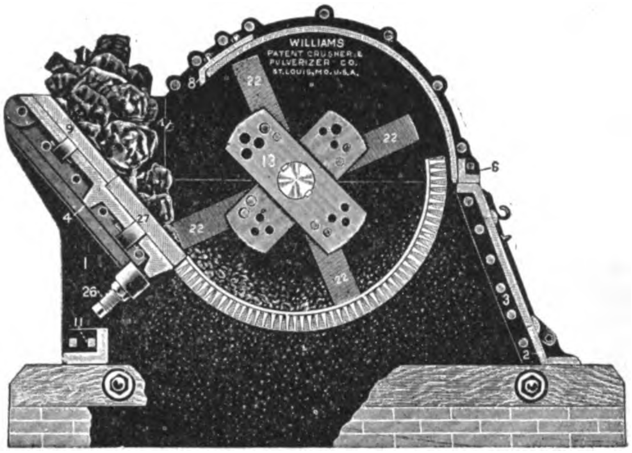
OLD COLONY BUILDING, CHICAGO
WORKS: ST. LOUIS
OFFICES: NEW YORK, SAN FRANCISCO, PHILADELPHIA, PITTSBURGH

COAL CRUSHERS FOR COKE OVEN WORK

Results—By the use of the Williams Patent Hammer Crushers with the various adjustable features, the following results are obtained from the ovens: The oven pulls easier, as the structure of the coke is more uniform—more coke is made from each oven, there being no waste, no black hearts and uncoked ends—the ash is reduced and added to the amount of coke produced—the coke comes out firm, regular in size, does not crumble, as it contains no cross fractures, and the structure is much improved. In a great many plants where these crushers have been used, the grade of coke has been raised from second and third to first quality. There is no question but that the application of a machine of this type to your plant will greatly improve the quality of your coke.

Bee Hive Oven—Where crushing coal for the ordinary bee hive oven, these regular machines should be used up to capacities of 200 tons per hour when crushing to ½" or ⅜", or up to 150 tons per hour when crushing to ¼" and finer, and up to 120 tons per hour when crushing to ⅛" and finer.

By-Product Oven—When working in connection with the improved By-Product ovens, this Regular type of crusher should be used where capacities run from 10 tons per hour upwards to 120 tons as the general specifications on crushed coal for by-product ovens are 85 to 90% ⅛" and finer.



REGULAR SPECIFICATIONS

Size Mill	Hopper Opening	Size Feed	Capacity Tons Per Hour			Speed	Size Pulley		Extreme Dimensions			Horse Power	Weight
	Inches		½" & finer	¼" & finer	⅛" & finer	R.P.M.	Diam.	Face	Length	Width	Height		Pounds
1	15 x 12	Run of Mine	30- 40	25- 30	20- 25	1000	20"	15"	6'	6' 6"	3' 9"	20-25	6500
2	20 x 12		45- 55	40- 50	30- 40	1000	20"	15"	6'	7' 6"	3' 9"	30-35	7500
3	30 x 16		65- 80	60- 70	45- 60	1000	20"	15"	6'	8' 6"	3' 9"	50-60	9500
4	40 x 18		100-115	80- 90	60- 80	1000	24"	18"	6'	9' 0"	3' 9"	75-80.	10500
5	50 x 20		120-140	100-110	75-100	1000	24"	20"	6'	9' 6"	3' 9"	100	12000
6	60 x 20		150-175	115-130	100-120	1000	24"	22"	6'	11' 0"	3' 9"	125	13500

We furnish a Williams Flexible Coupling in place of Pulley Without Extra Cost.

JUMBO CRUSHERS

General Construction—To give the reader some idea of the general construction of this type of machine, we would call attention to the fact that all of the Jumbos are 48" in diameter and of different widths, the No. 5 being 30" wide, the No. 6, 40"; the No. 7 is 48" wide, and the No. 8 is 60" wide. The hopper openings are very large and will accommodate the largest run of mine coal. The extreme height of this machine is 62½", the weights vary from 20,000 to 30,000 lbs., depending on the size.

JUMBO SPECIFICATIONS

Size Mill	Hopper Opening	Size Feed	Capacity Tons Per Hour			Speed	Size Pulley		Horse Power	Extreme Dimensions			Weight
	Inches		½" & finer	¼" & finer	⅛" & finer	R.P.M.	Diam.	Face		Length	Width	Height	Pounds
5	30 x 24	R. O. M.	150-175	120-140	80-100	750	24"	18"	85-100	8' 10"	9'	5' 4"	20000
6	36 x 24		180-200	145-165	120-140	750	30"	20"	140-150	8' 10"	10'	5' 4"	24000
7	48 x 30		225-250	200-220	150-175	750	30"	24"	165-185	8' 10"	11'	5' 4"	28000
8	60 x 30		275-300	250-275	180-200	750	30"	24"	200-250	8' 10"	13'	5' 4"	30000

CAMEL BACK CRUSHERS

These Camel Back machines are especially advocated for capacities at ½" and ⅜" crushing ranging from 200 to 400 tons per hour, at ¼" crushing from 150 to 250 tons per hour, and on ⅛" crushing from 125 to 200 tons per hour. An operator may have four or six rows of hammers, as desired; where run of mine coal is used, four rows are advocated by us and where slack, crushed, sized, or Bradford Breaker coal is used, six rows of hammers are advocated.

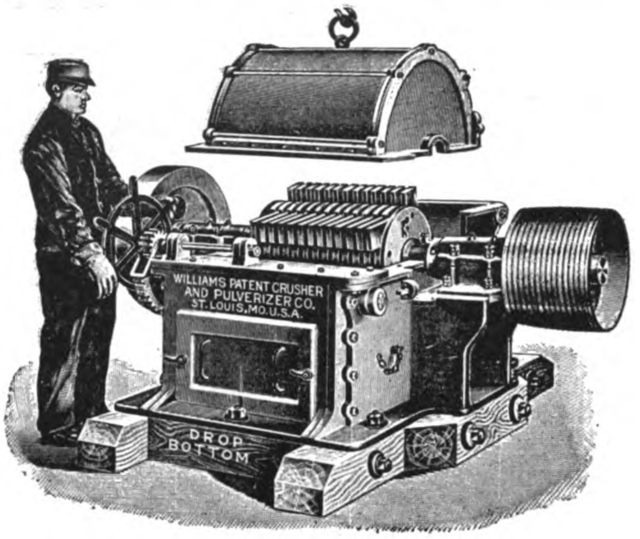
CAMEL BACK SPECIFICATIONS

Size Mill	Hopper Opening	Size Feed	Capacity Tons Per Hour			Speed	Size Pulley		Extreme Dimensions			Horse Power	Weight
	Inches		½" & finer	¼" & finer	⅛" & finer	R.P.M.	Diam.	Face	Length	Width	Height		Pounds
5	24 x 15	R. O. M.	120-140	100-115	75- 85	1000	24"	16"	7′ 6"	9′ 6"	4′ 5"	80- 90	15000
6	36 x 15		175-200	150-165	110-130	1000	24"	18"	7′ 6"	10′ 6"	4′ 5"	100-125	20000
7	48 x 15		225-260	200-225	135-175	1000	24"	20"	7′ 6"	11′ 6"	4′ 5"	140-160	24000
8	60 x 15		300-325	250-280	175-215	1000	24"	22"	7′ 6"	12′ 8"	4′ 5"	175-200	28000

CRUSHERS FOR SIZING COAL FOR STOKERS

The Williams Patent Coal Splitter takes Run of Mine Coal and reduces the same to 1½", 1¼", 1", ¾" and finer with the "minimum amount of fine dust," the only machine made that can be regulated to properly size coal. All parts are adjustable to wear; the crusher is also adjustable to give most any size coal desired.

All large industrial plants are no doubt troubled, from time to time, with a shortage of screenings. This is caused by many mine conditions, chief among which we believe to be the decreasing demand for lump, or the larger sizes of coal. Where a mine has little demand for special size coal, naturally, they can make a very small percentage of screenings or slack. It must also be taken into consideration that a very large percentage of industrial plants are now equipped with chain Grates or Stokers, which demand Slack or Screenings, consequently the demand for lump or run of mine is reduced, and to what many think is a dangerous point, therefore, the only remedy for a scarcity of Slack or Screenings is the adoption of Crushers, either at the Mine or at the plants where the coal is used.


WILLIAMS PATENT CRUSHER AND PULVERIZER CO. ST. LOUIS, MO. U.S.A.
DROP BOTTOM

BRIEF SPECIFICATIONS

No. of Crusher	Hopper Opening Inches	Weight	Horse Power	Capacity—Tons Per Hour R.O.M. to 1½" and Finer
1	15 x 12	6,500	15 to 20	25 to 40
2	20 x 12	7,200	20 to 25	50 to 60
3	30 x 16	9,500	40 to 50	75 to 100
4	40 x 18	10,500	60 to 75	100 to 125
5	50 x 20	12,000	85 to 100	135 to 175
6	60 x 20	13,500	100 to 125	180 to 220
7	48 x 36	22,000	135 to 175	250 to 275
8	60 x 36	30,000	200 to 250	300 to 375
9	60 x 40	40,000	275 to 350	400 to 500

CRUSHERS FOR MINE DEBRIS

In offering to the Anthracite trade our patent Hinged Hammer Debris Crushers for the reduction of Anthracite Debris or Culm, we do so, knowing that every Mine Manager, Superintendent, and Foreman, appreciates the value of crushing their refuse, and flushing it back into the Mines by water.

This is not a new idea; some mines have used this system for years, hence we believe that you are more or less familiar with this proposition, but on the subject of properly crushing and treating this material before flushing it into the mines, we think that we can be of some service to you, and will briefly call your attention to the crushers we have to offer for this work.

SPECIFICATIONS

Size Mill	Hopper Opening	Size Feed	Capacity Tons Per Hour			Speed	Size Pulley		Extreme Dimensions			Horse Power	Weight
	Inches		¾"	½"	¼"	R.P.M.	Diam.	Face	Length	Width	Height		Pounds
1	15 x 12	Run of Mine	30	20	15	1000	20"	15"	6′	6′ 6"	3′ 9"	20-25	6500
2	20 x 12		40	35	25	1000	20"	15"	6′	7′ 6"	3′ 9"	25-30	7500
3	30 x 16		65	50	35	1000	20"	15"	6′	8′ 6"	3′ 9"	40-50	9500
4	40 x 18		80	70	60	1000	24"	18"	6′	9′ 0"	3′ 9"	75-80	10500
5	50 x 20		115	85-100	75	1000	24"	20"	6′	9′ 6"	3′ 9"	100	12000
6	60 x 20		130	110-125	90-100	1000	24"	22"	6′	11′ 0"	3′ 9"	125	13500

Special Note—All Williams Crushers mentioned herewith are equipped with Adjustable hammers, adjustable disc plates, adjustable cages, adjustable Breaker Plates, extra heavy housing construction, lined with liners to protect housing from wear, heavy shafts, substantial dynamo journals, which mean the maximum capacity, minimum horse power, and minimum cost for maintenance or upkeep. No other similar crusher made has these features.

WRITE FOR COMPLETE COAL CATALOG NO. 50

Stedman's Foundry and Machine Works

Office and Works

AURORA, INDIANA, U. S. A.

Manufacturers of

Coal Disintegrators

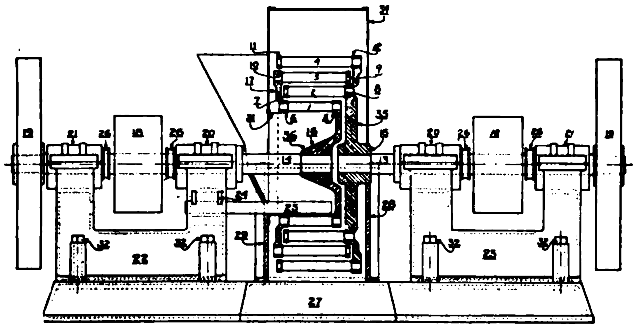
Products

Stedman's Coal Disintegrator; Crushing, Grinding, Pulverizing, Mixing and Screening Machinery of all kinds.

Pulverized Coal

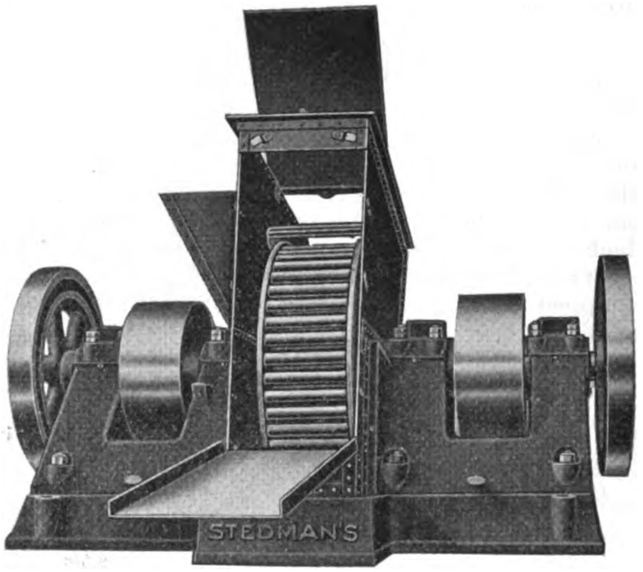
Pulverizing coal to improve the quality of coke is not an experiment but an acknowledged practical success by leading coke operators of the world. It not only improves the structure and density, but insures uniformity. The key to the best success and the greatest uniformity lies in the thorough mixing of the ground product to evenly distribute the ash and foreign material throughout the mass.

Our disintegrators are now in use in places where formerly coke produced from coal pulverized in other types of mills was very inferior. In other places they have replaced pulverizers which completely failed to produce saleable coke.



Operation

We attribute these facts to the particular manner in which our Disintegrator mixes and pulverizes the coal. As will be seen in the line drawing (Fig. 1), it consists of cages of round bars, similar to squirrel cages. The cages or rings of bars travel at moderate speed in opposite directions, and the oppositely revolving cages project between one another. The coal to be pulverized is fed into the center of the machine through the chute on the right. Within, the centrifugal force due to the rotation forces it between the bars where it is alternately beaten by the succeeding cages into a fine condition, and the ash and impurities thoroughly mixed and distributed. After passing the last cage it drops down the chute to a conveyor or hopper. Coal placed in the ovens in this condition sinters in a mass and all particles of coal are thoroughly coked, producing a hard coke with a good structure.



Stedman's Coal Disintegrator
Top and End Plates Removed to Show Construction.

Washed Coal

Our Disintegrator is the only type of pulverizing machine that will successfully pulverize washed coal. This feature should be particularly interesting to coke operators who are forced to use inferior coals. It is well known that in the oldest coking field of the country coals are now being used for coking that would not have been considered a generation ago.

Drive

There are several ways of driving the Disintegrator. The oldest method is driving with a single engine or motor with a jack shaft, crossing one of the belts to give the reverse motion to the cages. A newer and more satisfactory method is to use two individual motors set 25 to 30 feet back from the machine to prevent slippage of belts. This arrangement will eliminate the crossing of one belt which is admittedly not very satisfactory practice.

Size	No. Rings	Capacity Tons Per Hr.	Speed of Cages	Weight	Length	Width	Height	Size of Product.
60"	3	100-120	400-450	24,000	12'-0"	8'-0"	6'-6"	Rice grains or cracked wheat.
60"	4	95-110	400-450	22,000	12'-0"	8'-0"	6'-6"	Corn meal or finer.
50"	3	90-100	450-475	17,500	11'-0"	7'-0"	6'-2"	Rice grains or cracked wheat.
50"	4	80-90	450-475	16,500	11'-0"	7'-0"	6'-2"	Corn meal or finer.
44"	3	60-70	475-500	13,000	10'-3"	6'-0"	5'-3"	Rice grains or cracked wheat.
44"	4	50-70	475-500	12,000	10'-3"	6'-0"	5'-3"	Corn-meal or finer.
40"	4	30-50	500-525	10,000	10'-0"	5'-6"	5'-0"	Corn meal or finer.
36"	4	15-20	525-550	5,500	8'-2"	5'-0"	4'-3"	Corn meal or finer.

GENERAL ELECTRIC COMPANY

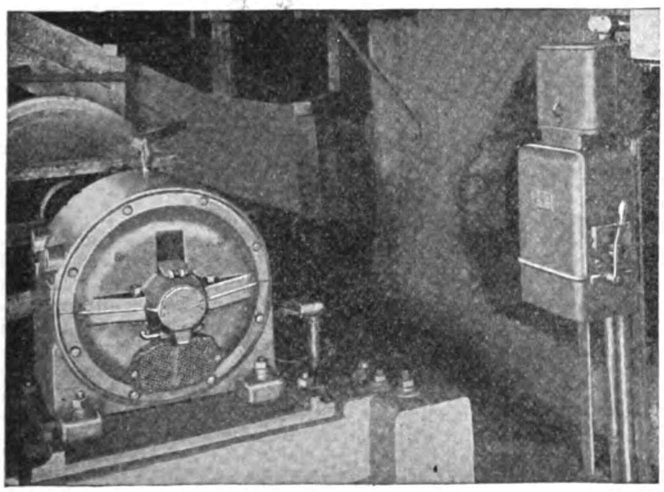
General Offices:
Schenectady, N. Y

The Guarantee of Excellence on Goods Electrical

Sales Offices
In All Large Cities

Electrical Equipment for Mines---Motors

Mine conditions are more severe than those met in any other branch of motor application. For this reason the General Electric Company, in collaboration with leading mine electrical engineers, has developed a complete line of alternating current motors which can be supplied for every mine requirement.



Mine Type Induction Motor, Driving Breaker Machinery. D. L. and W. Coal Co.

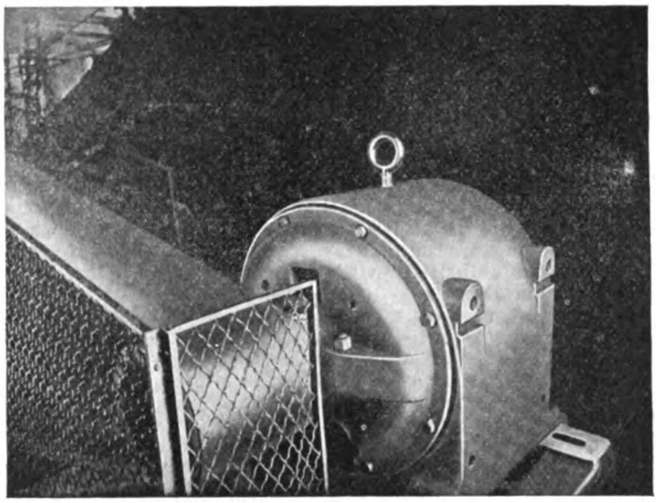
Their high starting effort and large capacity for severe overloads will often start and keep breaker machinery going when conveyors and screens are overloaded and crushers would jam were less power available. What is true in the breaker is typical of all severe mine service where these motors are extensively used.

The enclosed, self-ventilated, frame construction of these motors permits cooling the motor by clean air from outside the building. This air can be drawn in by the fan, which is enclosed in motor frame, through one pipe and discharged into another or into the building through a screened opening.

The unusually strong mechanical construction of these motors and their extra heavy shafts assure resistance to the many unexpected shocks encountered in mine work. An extra long bearing surface on shaft for rotor spider and a strong one piece back gear bracket are other features which give strength and solidarity. When back gear bracket is ordered it is firmly fastened to motor frame by four widely spaced bolts.

These motors can be opened for inspection without disturbing back shaft or gearing where the latter are used.

Bulletin No. 48011, "Electricity In Coal Mines," will be promptly sent on request.



G-E Motor, Driving Shaker Screen and Picking Table, Davis Coal and Coke Co., Thomas, W. Va.

HI motors are supplied in the following standard capacities:

MINE TYPE INDUCTION MOTORS.
Type H I Form K
5 to 75 HP. 60 Cycles—3 phase.
220, 440, 550 Volts.

H. P.	Syn. Speer	Approx. Ship. Wt. Motor and Comp.	Approx. Ship. Wt. With Back Gear and Comp.	Full Load Speed.
5	600	1100	1750	560
7½	900	1040	1700	845
10	900	1100	1750	845
10	600	1820	3100	555
15	900	1630	2730	850
15	600	2000	3270	560
20	900	1820	3100	845
20	600	2700	4560	555
25	900	2000	3270	860
25	600	2700	4560	560
35	900	2850	4700	865
35	600	3240	5360	565
50	900	3280	5400	855
50	600	3560	5700	570
75	900	3610	5750	860

Note—Above ratings can also be furnished as Form M—for variable speed.—10 HP. 600 r. p. m. and above.

WESTINGHOUSE ELECTRIC & M'F'G' CO.

EAST PITTSBURGH, PA.

SALES OFFICES

Atlanta, Ga.
Baltimore, Md.
Birmingham, Ala.
Bluefield, W. Va.
Boston, Mass.
Buffalo, N. Y.
Butte, Mont.
Charleston, W. Va.
Charlotte, N. C.
Chicago, Ill.
Cincinnati, Ohio.
Cleveland, Ohio.
Columbus, Ohio.
*Dallas, Tex.
Dayton, Ohio.
Denver, Colo.
Detroit, Mich.
*El Paso, Tex.
*Houston, Tex.
Indianapolis, Ind.
Joplin, Mo.
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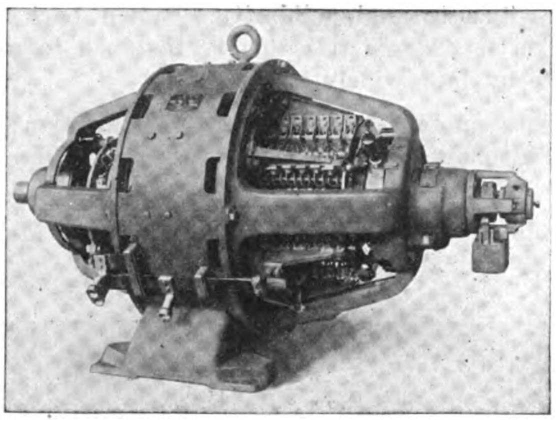
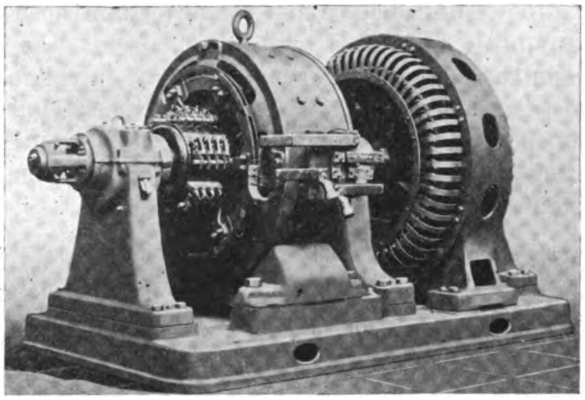
Salt Lake City, Utah.
San Francisco, Cal.
Weattle, Wash.
Syracuse, N. Y.
Toledo, Ohio.
Washington, D. C.
*W. & E. Co., of Texas.

Co-operative Service

Westinghouse Electric & Manufacturing Company, manufacturers of apparatus for both Generation, Application and Control of electric power, invite the Mine Operators to use the facilities of our engineering department in the planning and selecting of electrical equipment.



Mining Converter.



Motor Generator Set.

Motor Generator Sets

The large number of Westinghouse Motor-Generator Sets in successful operation have proven conclusively that they posses the usual Westinghouse qualities, such as simplicity, strength, ruggedness, compactness, economy, reliability and ability to withstand heavy overloads.

Construction Details

The rotating part consists of the motor rotating field and generator mounted on a common shaft. The synchronous motor field is equipped with a well distributed damper winding which renders the motor stable in operation and readily self-starting when a reduced voltage is applied to the stationary armature.

The generator field is built with frame of cast steel, having bolted in laminated main poles. The commutating poles are solid and bolted to the frame in a manner similar to the main poles. The well known Westinghouse direct-current machine field is used, which is noted for its open and well ventilated construction.

The commutating pole winding consists of a coil wound of bare strap on edge having only the first and last two turns insulated. The coil is held together and in place by four insulated bolts.

The direct current brush holders are bolted to arms that are supported rigidly from a rocker ring that fits into a recess in the frame, since these generators are equipped with commutating poles which automatically hold the best commutating point in a fixed position regardless of the load variation.

Continuous Rating K.W.	R.P.M.	Phase	Either A.C. or D.C. Starting Ship. Wt.
60 Cycle, 250 Volt, 250 Per Cent. O. L.			
•100	1200	6	3100
•150	1200	6	3900
•200	1200	6	4900
300	1200	6	7250
500	1200	6	12000
1000	900	6	25300
1500	600	6	38500
60 Cycle, 275 Volt, 100 Per Cent. O. L.			
•100	1200	6	3100
•150	1200	6	3900
•200	1200	6	4900
300	1200	6	7250
500	1200	6	12000
25 Cycle, 250 Volt, 100 Per Cent. O. L.			
300	750	6	13000
500	750	6	16200
750	750	6	24200
2000	300	6	69300

Continuous Rating K.W.	R.P.M.	Phase	Either A.C. or D.C. Starting Ship. Wt.
25 Cycle, 275 Volt, 100 Per Cent. O. L.			
300	750	6	13000
500	750	6	16200
60 Cycle, 270 Volt, Booster Converters (Voltage Range 240-300).			
500	1200	6	.13800
1000	900	6	28050
1500	600	6	42900
2000	400	6	71900
3500	225	6	135000
25 Cycle, 270 Volt, Booster Converters (Voltage Range 240-300).			
500	750	6	10500
1350	500	6	55000
2000	300	6	82700
4000	167	6	174000

Mining Converters

Fundamentally, commutating pole and non-commutating pole converters are the same, as the conversion is effected in the same manner. Commutating poles perform the same function in a rotary converter as in a direct current generator, i. e., hold the commutating point in a fixed position regardless of changes in load. In general, a commutating pole rotary converter will have less voltage drop from the A. C. brushes than a similar non-commutating pole machine. This is due to the fact that the use of commutating poles materially helps to reduce the voltage drop, and also allows the brushes to remain in a fixed position on the no-load neutral, thereby eliminating the drop resulting from shifting them forward to take care of the load condition.

Westinghouse Mining Converters are built in all sizes and are giving excellent service in many mines today. Specify Westinghouse Converters and be assured of UNFAILING DURABILITY.

Kw.	Speed	Bearings	P.F. %	Exciter Kw. 125-V.	Volts D.C.	Shipping Wt. Total
2 or 3 Phase—2200 Volts—A.C.—60 Cycles						
†50	900	3	100	2.5	125	7400
†50	900	3	100	2.5	250	7170
†50	900	3	100	2.5	275	7170
†75	900	3	100	2.5	125	7770
†75	900	3	100	2.5	250	7690
†75	900	3	100	2.5	275	7690
100	900	3	100	3	125	10430
100	900	3	100	3	250	9990
100	900	3	100	3	275	9990
100	900	3	100	3	600	9990
150	900	3	100	4.5	125	15615
150	900	3	100	4.5	250	14430
150	900	3	100	4.5	275	14430
150	900	3	100	4.5	600	14430
200	900	3	100	3.5	125	15810
200	900	3	100	3.5	250	15200
200	900	3	100	3.5	275	15200
200	900	3	100	3.5	600	15200
300	900	3	80	4.5	250	24200
300	900	3	80	4.5	275	24200
300	900	3	80	4.5	600	23400
500	900	3	80	6.5	250	36700
500	900	3	80	6.5	600	38000

THE FAIRBANKS COMPANY

Write Our Nearest Branch

ALBANY, N. Y.
BALTIMORE, MD.
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BRIDGEPORT, CONN.
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HARTFORD, CONN.
NEWARK, N. J.
NEW ORLEANS, LA.
NEW YORK, N. Y.

PHILADELPHIA, PA.
PITTSBURGH, PA.
PROVIDENCE, R. I.
ST. LOUIS, MO.
SYRACUSE, N. Y.
HAVANA, CUBA

Manufacturers & Dealers

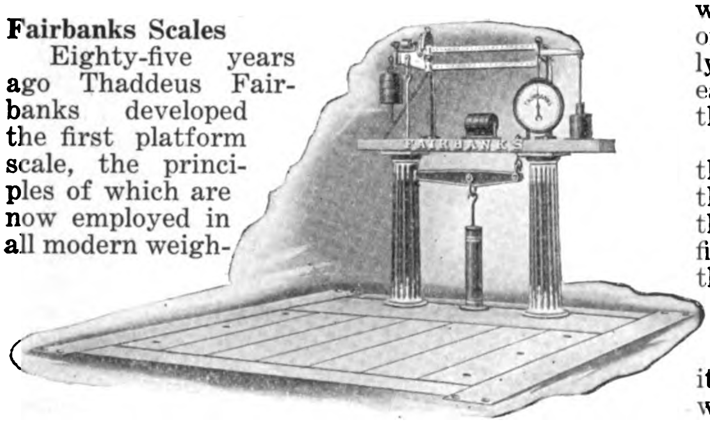
Scales of All Kinds, for All Purposes

Products

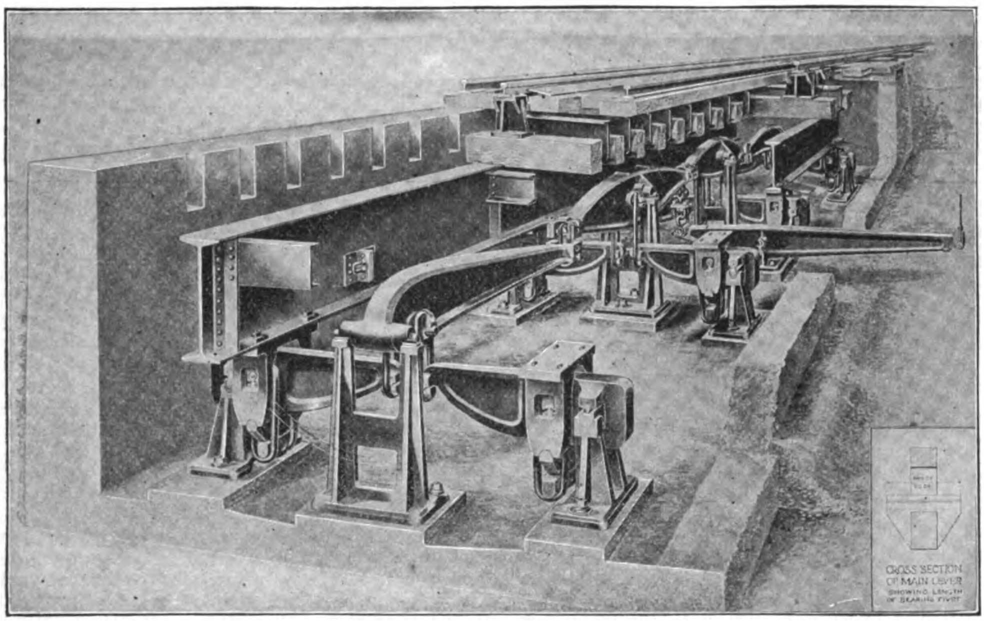
Scales, Valves, Trucks, and Wheelbarrows, Gasoline Engines, Pumps, Ventilators, Electric Light Plants, Power Transmission Machinery, Machine Tools, Power Hammers, Supplies.

Fairbanks Scales

Eighty-five years ago Thaddeus Fairbanks developed the first platform scale, the principles of which are now employed in all modern weighing machinery. During these eighty-five years the name **Fairbanks** has stood for superior weighing machinery.



Built-In Type with Quick Weighing Dial.



For weighing coal from the mine to the consumer, the three types of scales herein described are indispensable.

Coal Tipple Scale

The operation of the coal mine is dependent upon its tipple scale more than any other single piece of machinery used. This scale fixes the labor cost to the operator and measures the out-put of the mine. It is the place where interests of owner and miner meet. The scale should protect both and it can do so only through consistent accuracy which is obtained only in **Fairbanks** scales.

The tipple scale is sometimes built into the tipple, having a weighing hopper suspended from its levers to take the coal directly from mine cars, whence it is screened into the railroad cars below; or, it may be of the built-in type which is set directly into the ground or floor so that the loads may easily come onto the platform to weigh the coal in the mine cars.

To facilitate the weighing operation in order that the weight of the coal, either in the car or in the hopper, may be quickly shown, most scales of this type are equipped with a quick weighing outfit which consists of a dial attached to the end of the beam.

Railroad Track Scale

After the coal is delivered into the railroad cars it must again be weighed to determine the billing weight.

The Fairbanks Suspended Platform Track Scale is recognized by all large railroads and mining companies as the standard for this purpose. It is by far the most highly developed weighing machine on the market, conforming in detail to all the requirements of the American Railway Association.

Auto Truck Scales

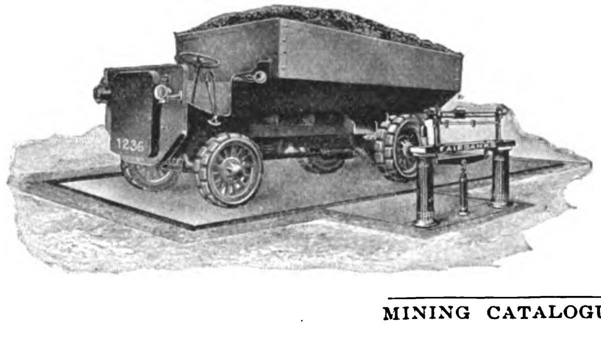
Before the coal is delivered to the consumer it must be weighed by the retailer. Here again accuracy is paramount and the need is supplied by **Fairbanks** Auto Truck or Wagon Scales.

All the scales described above are made in various modifications to meet local conditions.

In addition we have over one thousand other types for weighing other commodities.

Complete information and catalogs mailed on request.

If you have a special weighing problem we offer the counsel of our organization of experts, and our eighty odd years of experience is at your service.



The Standard Scale and Supply Company

PITTSBURGH, PA., 1631 LIBERTY AVENUE

NEW YORK
145 Chambers St.

PHILADELPHIA
523 Arch St.

CHICAGO
163-171 N. May St.

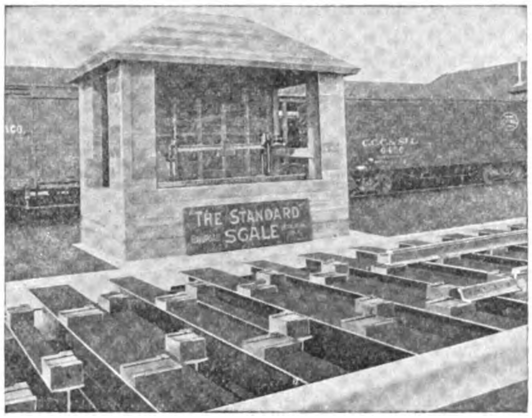
CLEVELAND
1547 Columbus Rd.

Manufacturers of

Weighing and Mixing Machinery

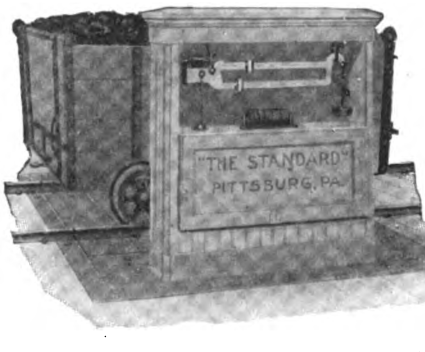
Products

Scales; Concrete Mixers; Engines, gas, gasoline and oil; Hoists; Coal Dealers' Supplies; Contractors' Equipment.



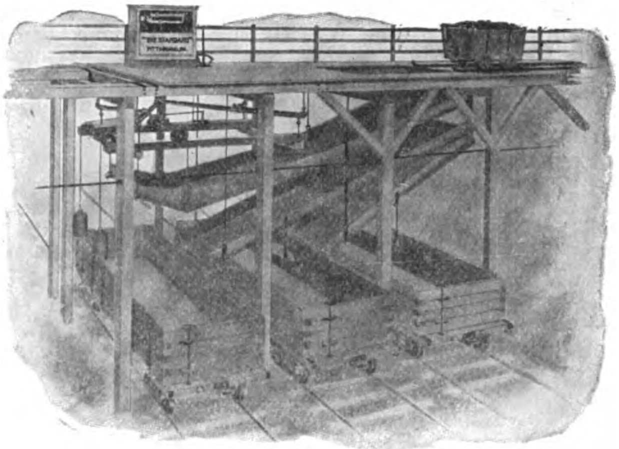
"The Standard" Modern Railroad Track Scale

Manufactured in capacities of from 6 to 300 tons and lengths of platforms running from 6 ft. up. On account of the arrangement of tipples it is frequently necessary to place two or more cars on the Scale platform at the same time. We are prepared to furnish a specially heavy type where the Scale is called upon to perform particularly heavy duty, or where it is necessary for a locomotive to pass over it. With the lighter pattern, a dead rail is usually provided. A single full capacity beam, graduated from 20 lbs up to the capacity of the Scale, either with or without Recording Attachment, is usually furnished. Double, Triple or special beams are frequently used and we are prepared to meet all demands.



"The Standard" Mine and Tipple Scale

Capacities 2 to 10 tons. Platforms of any size to accommodate mine cars. Usually furnished with Double Beam. Full capacity compound beams, either with or without Recording Attachment, furnished, if desired. This style can be erected either in tipple or on foundation in the ground.



"The Standard" Suspension Tipple Scale

for weighing coal after being dumped in the pans. Capacities 6 to 20 tons regular, although larger capacities are furnished when specified. The beams furnished are the same as furnished with the Mine and Tipple type. Extensions to locate the beam at any distance desired, and either above or below the mechanism.

General

"The Standard" line of scales includes practically all types for every purpose, in sizes from the small Counter graduated so fine as 1-16 ounce up through the general run of Express Package, Portable Platform, Dormant, Mine, Wagon, Auto-Truck, etc., to Railroad Track Scales of the heaviest capacity and longest platform.

Testing

A Scale, to retain its original accuracy, requires its share of attention like every other machine. As a rule, Scales of the heavier type are located in the open, subject to the weather and dirt. The Scale should be tested every thirty days. A supply of U. S. Standard Test Weights regularly placed upon the Scale to determine its accuracy is advisable. To insure that your Scale Equipment lives as long as it should, the Scales should be gone over by a competent Scale Mechanic at least six times a year. A little adjusting when needed often avoids the necessity of discarding the old and installing new equipment. Our Special Service Department is at your service. Write us for complete information regarding this service which adds efficiency and prolongs the life of your Scales.

Concrete Mixers

"The Standard" Concrete Mixer, on account of its low charging feature, light weight and portability, is perhaps used more extensively around the mines for concrete work than any other mixer made. Capacities 2 to 40 cu. ft. of unmixed material per batch. Our Concrete Mixer Catalogue No. 37 forwarded on application.

Engines: Pumps

A complete line of Gas, Gasoline, Oil and Steam Engines for every purpose. Capacities 1 h. p. up, either vertical or horizontal. Also a complete line of pumps.

Scales

Twenty-five years' experience in manufacturing Scales, and our location in the center of the coal industry places us in position to furnish the Coal Operator with the right Scales for the requirements and at prices in line with the grade of Scales needed.

Send for our Scale Catalogue No. 14, containing illustrations and list of the several hundred sizes we manufacture. Full information gladly sent whenever requested.

Streeter-Amet Weighing & Recording Co.

4101-05 Ravenwood Ave., Chicago, Ill.

Manufacturers of

Automatic Weight Recorders

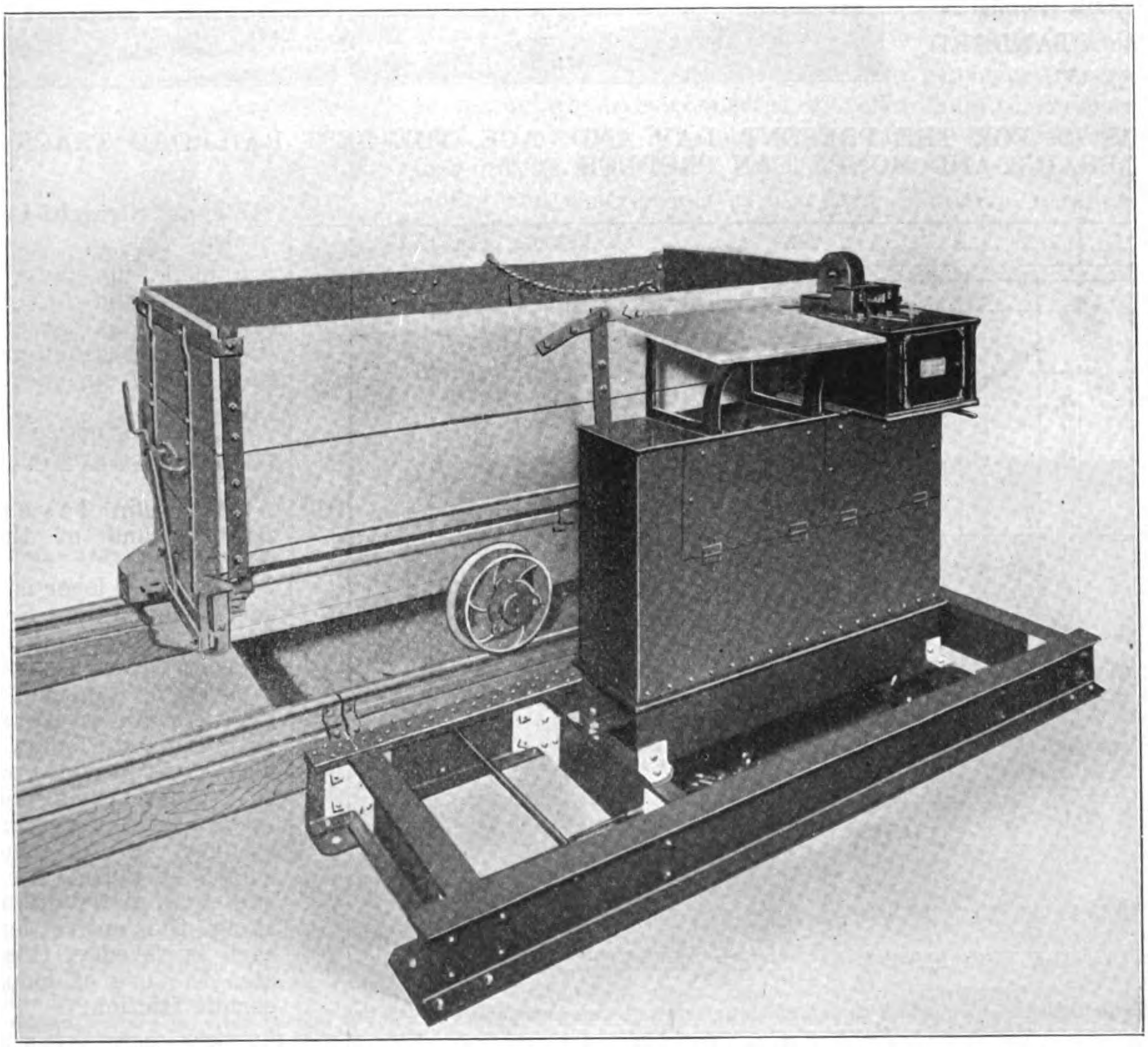
For Mine Tipple Scales and Railroad Track Scales

The Recorder automatically weighs each car and correctly registers the weight thereof on a paper tape, as the car passes over the scale platform and without stopping it thereon. Where commodity is weigher in hopped the Recorder comes to balance immediately after the load is deposited and the weight is recorded by the weighmaster releasing a small lever.

The recording apparatus is connected at the nose or end of the scale beam. The upward movement of the beam, when load is upon the scale, rotates the recording wheel until the numeral indication upon the wheel corresponding to the weight of the load is at the highest point directly beneath the printing hammer and in line with the indicator. The printing hammer is then released (actuated either automatically by the flange of the car wheel operating a trip lever on scale platform, or manually where commodity is weighed in hopper or basket) and the weight is recorded.

The Recorders permit of greater rapidity in the weighing operations and eliminate the human equation from the problem of obtainig correct weights. It automatically weighs and mechanically records, depending for the accuracy of its work only on the uniformly exact operation of carefully made mechanism and not on the uncertain human element.

The Recorders can be attached to any make of scale, provided capacity and design are suited to the work to be done.



Winslow Government Standard Scale Works, Inc.

Terre Haute, Indiana, U S A

Manufacturers of

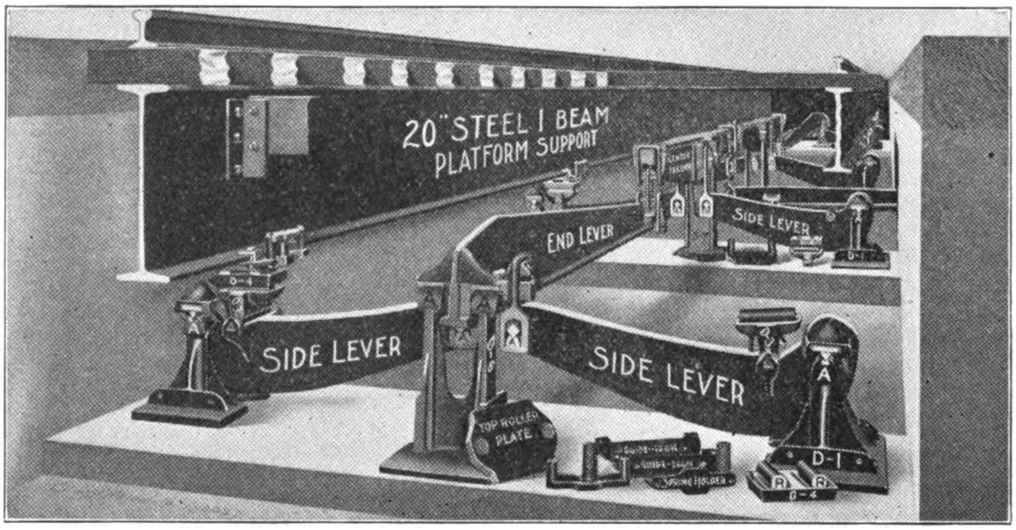
HEAVY CAPACITY SCALES

Products

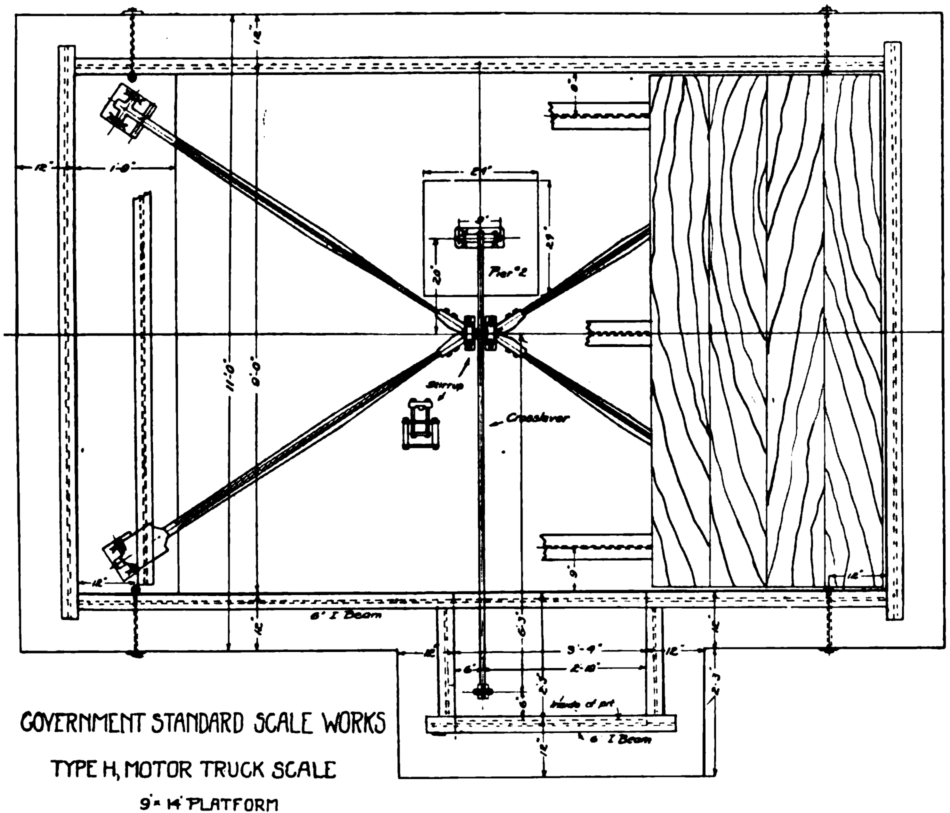
We manufacture all sizes of heavy Scales, from one ton to 325 tons capacity.

NOTHING SUCCEEDS LIKE SUCCESS.

No amount of shock can produce any slipping or scraping of the knife edge bearing on the surfaces with which they come into contact. An exclusive patented feature of WINSLOW GOVERNMENT STANDARD SCALES.



THIS IS, FOR THE PRESENT DAY AND AGE, THE BEST RAILROAD TRACK SCALE THAT BRAINS AND MONEY CAN PRODUCE.



The above cut shows our "H Type" Straight Lever Wagon and Motor Truck Scale.

"H Type" Straight Lever Scales

are made in many sizes of platform and of different capacities to accommodate the various requirements of the trade, from one to thirty tons.

You will notice that no main levers are held in suspension.

All main levers are straight and of the same multiple.

One main lever is not supported by another. Each main lever is made amply strong to support the entire rated capacity of the scale.

All main levers are supported on stationary stands, which are provided with self adjustable bearing blocks to receive knife edges, in such a manner as to insure full length of knife edge contact and equal distribution of load along the entire length of each knife edge, this eliminates the use of loops which permit friction.

We Make a Specialty of Strong Motor Truck Scales.

Manierre Engineering & Machinery Co.

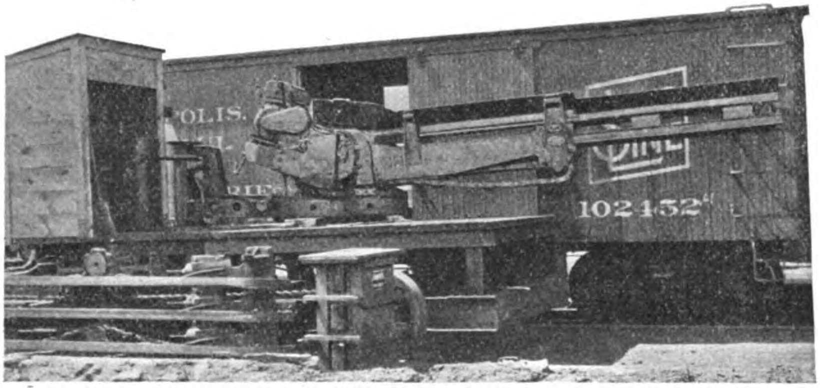
Manufacturers of

BOX CAR LOADERS

Milwaukee, Wisconsin

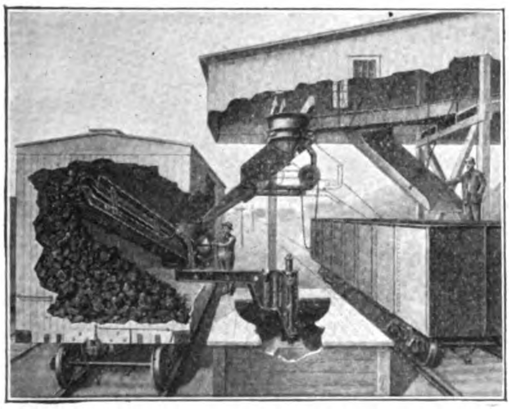
Description of Standard Manierre Box Car Loaders

The long reach Manierre box car loader differs from other loaders in that it is a conveyor. The conveyor can be tilted so as to minimize the drop, and the new Manierre extension type loader extends 18′ 6″ maximum from the center line of the car door, thus reaching to the extreme end of any box car. Coal six inches or under is turned in the direction of the belt as it comes from the chute, to reduce breakage. The center of the car can be filled by this loader. Thus every detail of the Manierre is planned to reduce breakage. The construction of the loader is simple. It is easy to operate. It is moved by hand, and is supported on two hinged arms journalled on ball and roller bearings. The conveyor frame carries the motor which is connected by roller chain to conveyor drive shaft. It occupies little space, and can be installed under the most difficult conditions. Below are some specifications for coal loading and descriptions of standard Manierre arrangements.



The New Extension Loader.

Name	To Load	H. P.	Per Hour Cap. 30 Ton Cars	Belt Speed
16″ Belt	6″ and under	5	3 to 4	375 to 875
24″ Belt	6″ and under	7½	4 to 6	350 to 700
24″ Steel Apron	Mine Run	20	6 to 8	350 to 700
Extension	Lump	20	6 to 8	175 to 350



Showing Typical Installation at Mine.

STANDARD ARRANGEMENT.

1—Single acting loader on same side of car as chute with loader standing in off position at right angles or parallel to car with arms swung above operating platform or inverted. Operates in connection with our standard chute, having side to side motion and moved in and out by chain wheel.

2—Double acting loader loading on either side between tracks spaced preferably 19′ centers. Chute same as the single acting except that it can be turned 180 degrees from one track to the other. Double arrangement saves time of spotting cars also makes it possible to fill center of loaded car with chute while loader is being placed in other.

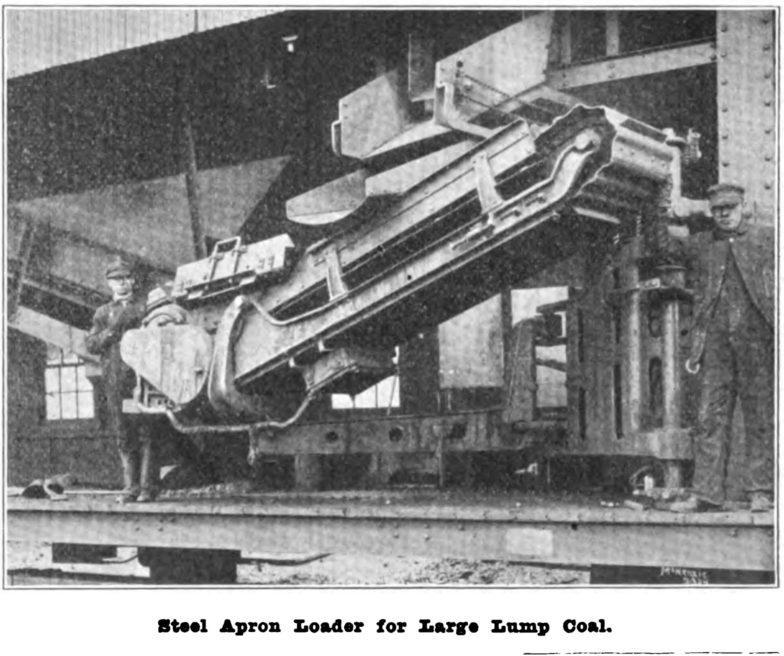
3—Loader installed with long arms so as to take coal from chute coming in on either or both sides of car.

4—Single acting loader with chute arrangement to load open cars on one track while changing box cars on a second track; thus saving time lost in spotting cars.

5—Portable loader hand traversed or equipped with traction motor to pull 6 loaded 30 ton cars. If chute is on loader side, chute can be carried on car with hopper and screens to load in connection with steam crab or under line of pockets.

6—We design loaders to meet special needs.

"FIVE FIRMS USE THIRTY MANIERRES, BECAUSE 'MANIERRE LOADED LUMP' PAYS."



Steel Apron Loader for Large Lump Coal.

OTTUMWA BOX CAR LOADER CO.

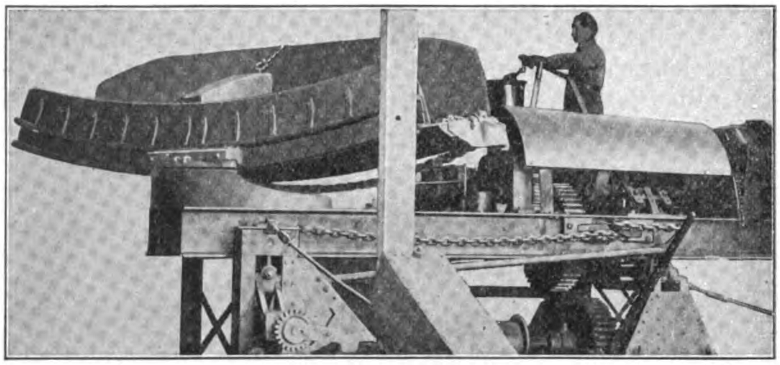
OTTUMWA, IOWA

OTTUMWA BOX CAR LOADER CO.
OTTUMWA IOWA

Ottumwa Loaders are built in more than thirty-five models, including steam and electric, also portable, semi-portable and stationary, cradle gravity, rotary paddle wheel and special models for extraordinary conditions.

The Ottumwa Company are the oldest manufacturers of Box Car Loaders now in existence. Their experience is worth thousands of dollars to you. Hundreds of Ottumwa Loaders are in daily operation.

The "Ottumwa" idea has always been PREPARATION, and Ottumwa Loaders will handle coal with less breakage than any other loader manufactured. Carrying hoppers and extra long conveyors eliminate throwing, falling, pushing and grinding.



Ottumwa Stationary Electric Pusher Type.

Notice Absence of Breakage of these Big Chunks.

Ottumwa Steam Pusher Loader.

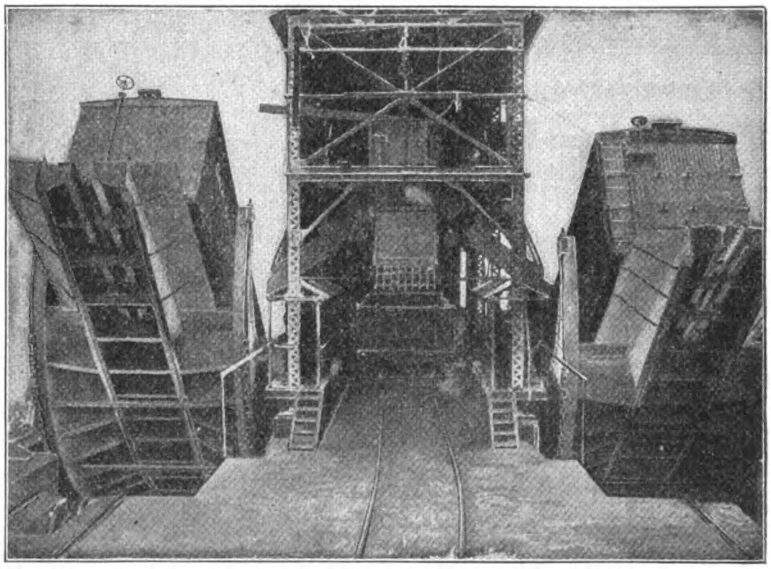
Labor Scarcity today together with increased cost of operation necessitates labor saving machinery. Ottumwa Loaders will save from three to sixteen men, prevent delays, increase your tonnage and swell the dividend. Only a limited tonnage can be loaded in box cars by hand, and if **your ambition is greater production,**

the solution is an Ottumwa Loader.

Box cars are rapidly coming into more general use and the necessity for an Ottumwa Loader is becoming greater. Metal market conditions are serious and deliveries are becoming delayed.

Heed This Warning

Place your order immediately and assure yourself of a Loader for fall and winter use.

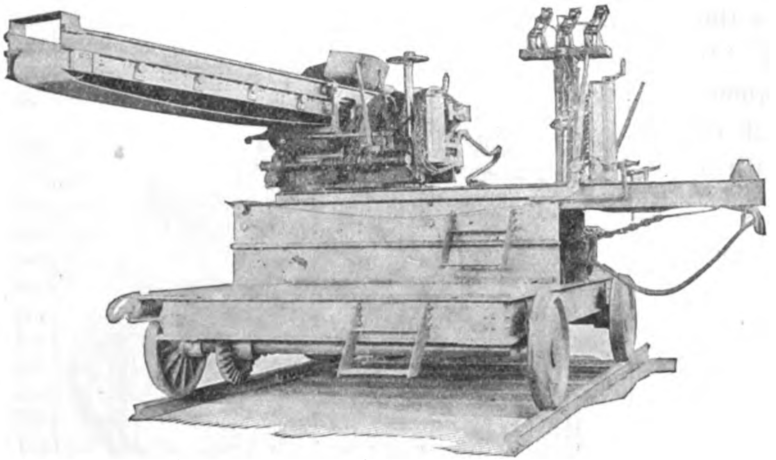


Two Ottumwa Cradle Box Car Loaders. The only Loader made with Unlimited Capacity.

THREE COMPANIES HAVE THIRTY OTTUMWA LOADERS.

OTTUMWA BOX CAR LOADER CO.

OTTUMWA, IOWA



Portable Ottumwa Belt Conveyor or Loader.

"Ottumwa Belts" Will Fill Your Needs

With a mechanical conveyor that is almost human.

Moves back and forth, up and down, and from side to side.

Carefully carries coal and actually places it where desired.

All throwing, pushing, crushing and grinding eliminated.

Loads your coal fast or slow at operator's will.

Handles large tonnage without delay.

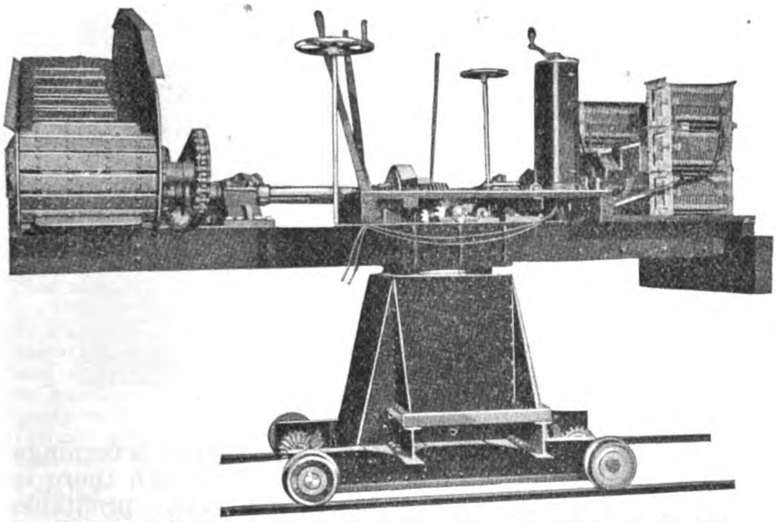
Made in both portable and stationary models.

Extra long conveyor to carry coal into ends of car.

Rubber belt for small prepared sizes.

Steel belt for large lump coal.

Increases the output of your mine.



Christy 3-C Model Conveyor or Loader. Hundreds of Christy Loaders in Daily Use.

Helps overcome ever increasing labor shortage.

Loads cars up to their capacity.

An excellent loader for anthracite also.

One company has purchased seven.

The New Ottumwa Belt Loader

Distinctive features in "Ottumwa" only:

Every operation is mechanical.

Can be power driven in and out of car.

Prevents breakage by commencing to load coal down near floor and near center of car. Conveyor is then gradually moved forward at the same time raised so that coal is well distributed but never allowed to fall.

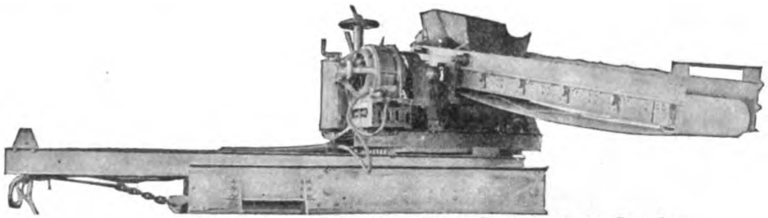
Both ends of car loaded without removing loader or stopping the flow of coal. A great time saver.

Mechanically swung from side to side of car.

Conveyor stands squarely in middle of car and distributes equally on either side.

Belt is reversible and runs in either direction.

Can receive large and small coal from either car door.



Stationary Ottumwa Belt Conveyor or Loader.

Operator stands entirely outside car out of dust where he can see and avoids personal danger.

The **Ottumwa Box Car Loader Co.** has recently purchased the entire business of the **Christy Box Car Loader Co.** of Des Moines, Ia., and are now furnishing Christy Loaders to those who desire that type of loader.

The 3-C Christy type of loader here illustrated now built by the Ottumwa Company is especially designed for loading large tonnages, and is particularly adapted to the handling of run of mine coal.

A long conveyor is mounted on a counter balanced frame which in turn is balanced on a small standard gauge truck. This particularly operated truck eliminates the necessity of a permanent foundation. The loader, by reason of being pivoted on this truck, allows the long conveyor to enter the car diagonally. When in the car the conveyor straightens out and the main frame is swung diagonally allowing the coal to be carried a long distance into the ends. We also make other types of the Christy model.

INFORMATION AND CATALOGS GLADLY FURNISHED FREE ON REQUEST.

MALCOLMSON BRIQUET ENG. CO.

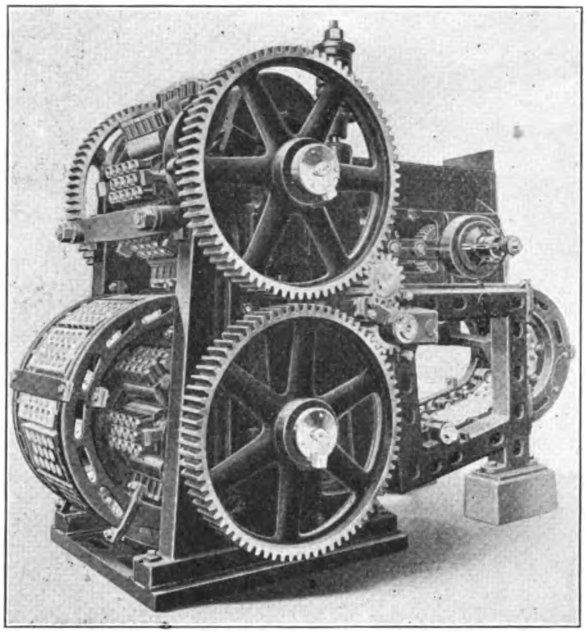
OLD COLONY BLDG, CHICAGO, Ill.

CONSULTING AND CONTRACTING ENGINEERS

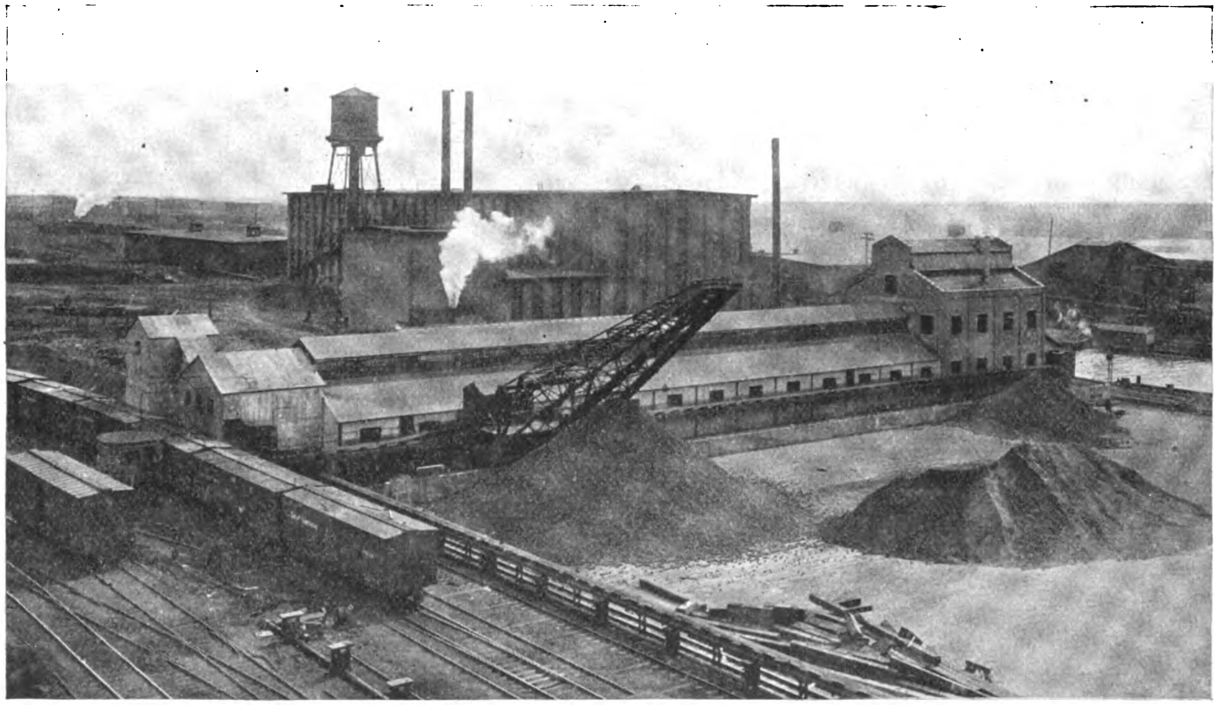
Complete Coal Briquetting Plants

The Rutledge briquetting press represents the latest improvement in briquetting machinery. It was developed to meet the requirements of American conditions, by producing a large output of small briquets, made under high pressure with a small percentage of binder.

The Rutledge press is of the continuous mold type. It consists essentially of a chain of molds or die plates, passing under a feeding hopper and between two revolving drums, upon which punch rams are carried. Two pilot punches on each punch ram engage the die plates in advance of the entrance of the punches into the dies; these pilot punches not only serve to move the dies forward, but insure perfect alignment of the dies and punches. The lower punches enter the dies again at the lowest point of their travel, and eject the briquets.



Rutledge Briquetting Press.



Berwind Fuel Company's Plant, Superior, Wisconsin.

The Rutledge press and other specialized machinery; the selection of the best coal handling equipment; and the carefully worked out design make this plant the largest and most complete in the country. It represents, also, the latest development in a process for the conversion of screenings into high-priced domestic fuel, for which there is an immediate, ever-increasing and profitable market. Investigate the possibilities of coal briquetting in your territory. Write us for catalog. Your correspondence is solicited.

MASHEK ENGINEERING COMPANY

90 WEST STREET, NEW YORK, N. Y.

Manufacturers of

COAL BRIQUETTING MACHINERY

We build a complete line of special briquetting machinery for the equipment of plants from one end to the other, from our own designs and patterns, developed by long experience. None of our machinery equipment is experimental or untried.

We are the oldest firm in the United States making a specialty of building briquetting machinery and plants to briquet any fuel. Our plants are briquetting charcoal, bituminous coal, coke brieze, anthracite coal and lignite, using most suitable binders and processes to meet conditions the fuel is used for. We have equipped two-thirds of the plants in the United States and Canada. All our plants are commercially successful. We have equipped all plants in the United States using patented or secret binders, producing a smokeless product that is waterproof and harder than natural anthracite coal no matter what coal is briquetted.

Size and Capacities of Plants

We build three sizes of standardized briquet plant equipments, as follows:

Type "Y-1"—4½ tons of 2 oz. briquets, 7 tons of 4 oz. briquets per hour.

Type "M-2"—9 tons of 2 oz. to 15 tons of 5½ oz. briquets per hour.

Type "C-3"—18 tons of 2 oz. to 30 tons of 5½ oz. briquets per hour.

Lignite

Our standard equipment will convert lignite into a fixed fuel practically smokeless and equal in heating value to Pennsylvania anthracite, using any kind of binder desired.

Binders

Our machinery will produce briquets using any binder, and use a smaller percentage of it than any other machinery built anywheres, and make a harder product. Our plants are using coal tar pitch, asphalt residium, (either in hot, melted, liquid, or pulverized state) flour and oil, sulphite pitch waterproofed, and other patented and secret smokeless binders. Our product in all cases is waterproof and retains its hardness until consumed. Unless a customer has his own binder, we recommend and furnish a suitable binder to briquet any fuel to meet any market.

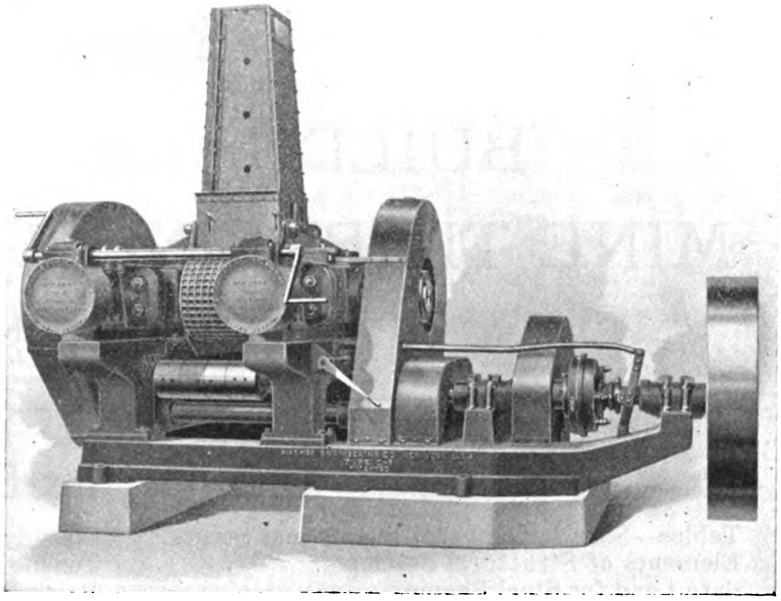
Size and Shape of Briquets

Our Standard roll shell patterns will produce briquets weighing 1⅝, 2, 2¼, 3, 4 and 5 oz. briquets. Change from one size to another can be made quickly. The over-stuffed pillow shape briquet was brought out and developed by us, which experience has shown will have less breakage in handling and transportation than any lump or prepared coal. The briquets will spout shovel and handle the same as ordinary coal. This shape briquet gives the best results during combustion, no matter from what coal they are made.

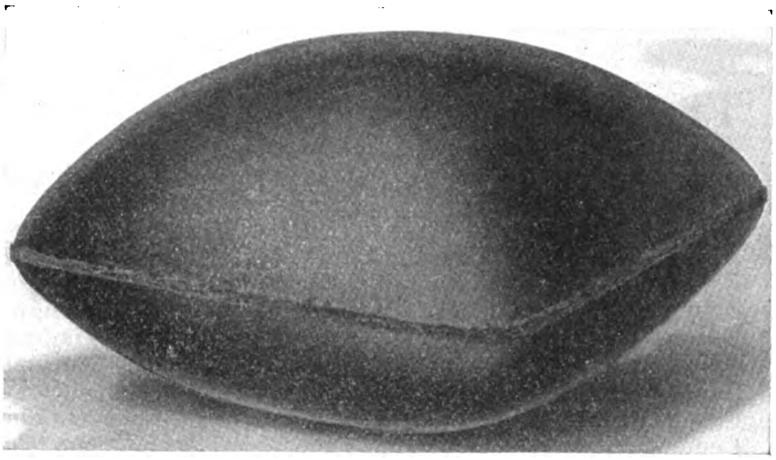
Catalog

Our catalog No. 4 covers the subject of briquetting any fuel in detail, shows illustrations, drawings and photographs, costs of plants, cost of manufacture, etc., which we would be pleased to mail free to those who may desire to convert their breakage into fuel that will command an equal or a better price than the best quality lump or prepared sizes of coal. To others the price of this catalog is one dollar.

We invite correspondence from those interested. If quality of product, efficiency, low cost of renewals of plant is considered, we have no competition.



Type C-3 Briquet Press. Capacity 18 to 30 Tons Per Hour. Weight 42,000 Lbs.



5 Oz. Briquet—Exact Size.

1⅝ Oz. Briquet—Exact Size.

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

BUILDING MATERIALS MINE TIMBERING AND SUPPORTS SECTIONS.

Engineering Data

Tables—Safe Loads Steel Beams and Struts.
Elements of Structural Sections.
Safe Load for Steel Beams.
Safe Load Beams and Posts of various Woods.
Lumber Table.
Board Measure.
Specific Gravity and Weights of Woods.
Tensile Strength of all materials.
Brick Work.
Stone Work.
Concrete in Mine Construction.

The following manufacturers and dealers have catalogue descriptions in this section:

Aladdin Co., The.
American Sheet & Tinplate Co.
Baltimore Roofing & Asbestos Mfg. Co.
Barrett Company, The.
Billings-Chapin Co., The.
Cabot, Samuel, Inc.
Carnegie Steel Co.
Carey, Philip Mfg. Co., The.
Cement Products Co.
Certain-Teed Products Corp.
Cheesman & Elliott.
Detroit Graphite Co.
Diamond Construction Co.
du Pont Chemical Works.
Harris Pump & Supply Co.
Huntington Lumber & Supply Co.
Johns-Manville, H. W., Co.
Keasbey & Mattison Co.
Kettle River Co.
Lawrence, W. W. & Co.
Lehigh Portland Cement Co.
Manufacturers' Distributing Co.
National Fire Proofing Co.
National Roofing Co.
National Paint & Varnish Co., The.
North Carolina Pine Association.
Northeastern Co., The.
Puritan Paint & Oil Co.
Republic Creosoting Co.
Sherwin-Williams Co., The.
Stark Rolling Mill Co., The.
Trussed Concrete Steel Co., The.
U. S. Varnish Co.

For additional descriptions of Mine Timbering and Building Materials not appearing in this section, refer to Index of Products in front of book.

STEEL BEAMS AND STRUTS

EXPLANATORY NOTES

Tables of safe loads for H and I sections as beams:—The safe loads given in tables are based upon extreme fiber stresses of 16,000 pounds per square inch. Safe loads include the weight of the beam and are assumed to be uniformly distributed.

For beams without lateral supports, when the span exceeds 20 times the flange width, the tabulated safe loads should be reduced as shown in the following tables:

Length of Beam	Maximum Safe Load	Length of Beam	Maximum Safe Load
20 x flange width	full tabulated load	50 x flange width	$\frac{7}{10}$ of tabulated load
30 x " "	$\frac{9}{10}$ of " "	60 x " "	$\frac{6}{10}$ " " "
40 x " "	$\frac{8}{10}$ of " "	70 x " "	$\frac{5}{10}$ " " "

The safe loads given above the horizontal lines shown in tables are the extreme safe loads based upon the safe strength of the web and should not be exceeded for shorter spans to avoid crippling of the web due to shearing strains.

The Deflection Coefficients, derived from fiber stress 16,000 pounds and modulus of elasticity of 29,000,000 pounds per square inch, are given for the maximum uniformly distributed loads on various spans. The maximum deflection, in inches, of a beam in the center of its span is obtained by dividing the deflection coefficient by the depth of the beam in inches.

For loads concentrated in the center of a span, use one-half of the safe loads given in table; the deflection is four-fifths of the deflection produced by the maximum safe load uniformly distributed over the span.

Tables of Safe Loads for H-sections as Struts and for Double Channel Struts:—The safe loads given in tables are assumed to be centrally applied and have been determined in accordance with the requirements of the New York Building Law. The allowable compressive stress in pounds per square inch is as follows;—

$P = 15{,}200 - 58\frac{l}{r}$. $\frac{l}{r} = \frac{\text{unsupported length of strut, in inches}}{\text{least radius of gyration, in inches}}$

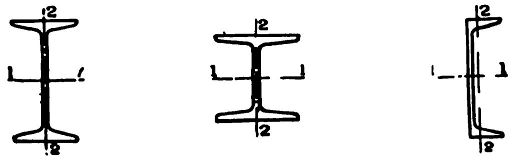
the allowable ratio of $\frac{l}{r}$ ranging between 55 and 120, equivalent to a maximum and minimum stress of 12,000 and 8,240 pounds per square inch, respectively.

Note.—The safe loads of Double Channel Struts are based upon the least radii of gyration equal to radii about axis perpendicular to web and do not apply in cases where the distance between channels would be less than one-half the depth of the channels.

Tables of Pins:—The tables for pins have been calculated for shearing, bending and bearing stresses. The stresses allowed, in pounds per square inch, are as follows:—

Single shearing stress,	-	10,000 lbs. per sq. in.
Bending stress,	- -	20,000 lbs. per sq. in.
Bearing stress,	- -	20,000 lbs. per sq. in.

ELEMENTS OF STRUCTURAL SECTIONS



Section Index	Depth of Section	Weight per Foot	Area of Section	Width of Flange	Thickness of Web	Axis 1-1			Axis 2-2		
						I	r	S	I	r	S
	In.	Lbs.	In.²	In.	In.	In.⁴	In.	In.³	In.⁴	In.	In.³
				ELEMENTS OF STRUCTURAL BEAMS							
B 1	24	80.0	23.32	7.000	0,500	2087.2	9.46	173.9	42.9	1.36	12.3
B 3	20	65.0	19.08	6.250	0.500	1169.5	7.83	117.0	27.9	1.21	8,9
B 80	18	55.0	15.93	6.000	0.460	795.6	7.07	88.4	21.2	1.15	7 1
B 5	15	60.0	17.67	6.000	0.590	609.0	5.87	81.2	26.0	1.21	8.7
B 7	15	42.0	12.48	5.500	0.410	441.8	5.95	58.9	14.6	1.08	5.3
B 9	12	31.5	9.26	5.000	0.350	215.8	4.83	36.0	9.5	1.01	3.8
B 11	10	25.0	7.37	4.660	0.310	122.1	4.07	24.4	6.9	0.97	3.0
B 13	9	21.0	6.31	4.330	0.290	84.9	3.67	18.9	5.2	0,90	2.4
B 15	8	18.0	5.33	4.000	0.270	56.9	3.27	14.2	3.8	0.84	1.9
B 17	7	15.0	4.42	3.660	0.250	36.2	2.86	10.4	2.7	0.78	1.5
B 19	6	12.25	3.61	3.330	0.230	21.8	2.46	7.3	1.9	0.72	1.1
B 21	5	9.75	2.87	3.000	0.210	12.1	2.05	4.8	1.2	0.65	0.8
				ELEMENTS OF H—BEAMS							
H 4	8	34.0	10.00	8.000	0.375	115.4	3.40	28.9	35.1	1.87	8.8
H 3	6	23.8	7.00	6.000	0.313	45.1	2.54	15.0	14.7	1.45	4,9
H 2	5	18.7	5.50	5.000	0.313	23.8	2.08	9.5	7.9	1.20	3.1
H 1	4	13.6	4.00	4.000	0.313	10.7	1.63	5.3	3.6	0.95	1.8
				ELEMENTS OF STRUCTURAL CHANNELS							
C 1	15	55.0	16.18	3.818	0.818	430.2	5.16	57.4	12.2	0.87	4.1
		33.0	9.90	3.400	0.400	312.6	5.62	41.7	8.2	0.91	3.2
C 2	12	40.0	11.76	3.418	0.758	196.9	4.09	32.8	6.6	0.75	2.5
		20.5	6.03	2.940	0.280	128.1	4.61	21.4	3.9	0.81	1.7
C 3	10	35.0	10.29	3.183	0.823	115.5	3.35	23.1	4.7	0.67	1.9
		15.0	4.46	2.600	0.240	66 9	3.87	13.4	2.3	0.72	1.2
C 4	9	25.0	7.35	2.815	0.615	70.7	3.10	15.7	3.0	0.64	1.4
		13.25	3.89	2.430	0.230	47.3	3.49	10.5	1.8	0.67	0.97
C 5	8	21.25	6.25	2.622	0.582	47.8	2.77	11.9	2.3	0.60	1.1
		11.25	3.35	2.260	0.220	32.3	3.11	8.1	1.3	0.63	0.79
C 6	7	19.75	5.81	2.513	0.633	33.2	2.39	9.5	1.9	0.56	0.96
		9.75	2.85	2.090	0.210	21.1	2.72	6.0	0.98	0.59	0.63
C 7	6	15.5	4.56	2.283	0.563	19.5	2.07	6.5	1.3	0.53	0.74
		8.0	2.38	1.920	0.200	13.0	2.34	4.3	0.70	0.54	0.50

Courtesy Carnegie Steel Co.

H-SECTIONS AS BEAMS

Safe Loads in Pounds, for Uniformly Distributed Loads

Bending Stresses, 16,000 pounds per square inch

Length of Span, Feet.	8" H 34 0 Lbs. I_{1-1} 115.42 ins.⁴ S_{1-1} 28.86 ins.³	6" H 23.8 Lbs. I_{1-1} 45.12 ins.⁴ S_{1-1} 15.04 ins.³	5" H 18.7 Lbs. I_{1-1} 23.77 ins.⁴ S_{1-1} 9.51 ins.³	4" H 13.6 Lbs. I_{1-1} 10.69 ins.⁴ S_{1-1} 5 34 ins.³	Coefficients of Deflection
2				28800 28500	0.066
3				19000	0.149
4			34800 25350	14250	0.265
5		39970 32080	20280	11400	0.414
6	60640 51300	26740	16900	9500	0.596
7	43970	22920	14490	8140	0.811
8	38470	20050	12680	7130	1.059
9	34200	17820	11270	6330	1.341
10	30780	16040	10140	5700	1.655
11	27980	14580	9220	5180	2.003
12	25650	13370	8450	4750	2.383
13	23680	12340	7800	4380	2.797
14	21990	11460	7240	4070	3.244
15	20520	10690	6760	3800	3.724
16	19240	10030	6340	3560	4.237
17	18110	9440	5970		4.783
18	17100	8910	5630		5.363
19	16200	8440			5.975
20	15390	8020			6.621
21	14660				7.299
22	13990				8.011
23	13380				8.756
24	12820				9.534

DEFLECTION IN CENTER OF SPAN, IN INCHES.

For loads uniformly distributed over span, $\frac{\text{coefficient}}{\text{depth of beam in inches.}}$

For loads concentrated in center of span, $\frac{4}{5} \times \frac{\text{coefficient}}{\text{depth of beam in inches.}}$

H-SECTIONS AS STRUTS

Safe Loads in Pounds, for Direct Loads

Compressive Stresses, $15200 - 58\frac{l}{r}$ pounds per square inch

Length of Struts Feet	8" H 34.0 Lbs. Area 10.00 ins.² min. r 1.87 ins.	6" H 23.8 Lbs. Area 7.00 ins.² min. r 1.45 ins.	5" H 18.7 Lbs. Area 5.50 ins.² min. r 1.20 ins.	4" H 13.6 Lbs. Area 4.00 ins.² min. r 0.95 ins.	Length of Struts Feet
5				48000 46150	5
6			66000 64460	43220	6
7		84000 82880	61270	40290	7
8		79520	58080	37360	8
9	120000 118500	76160	54890	34430	9
10	114780	72800	51700	31500	10
11	111060	69440	48510		11
12	107340	66080	45320		12
13	103610	62720			13
14	99890	59360			14
15	96170				15
16	92450				16
17	88730				17
18	85000				18

Safe loads above horizontal lines are based upon 12000 pounds per square inch, equivalent to ratio of $\frac{l}{r} = 55$.

Maximum allowable ratio of $\frac{l}{r} = 120$ is equivalent to a stress of 8240 pounds per square inch.

I-SECTIONS AS BEAMS

Safe Loads in Pounds, for Uniformly Distributed Loads

Bending Stresses, 16000 pounds per square inch

Length of Span, Feet	5″x3.00″ I 9.75 Lbs.	6″x3.33″ I 12.25 Lbs.	7″x3.66″ I 15 Lbs.	8″x4.00″ I 18 Lbs.	9″x4.33″ I 21 Lbs.	10″x4.69″ I 25 Lbs.	Coefficients of Deflection
3	21090 17200	34470 25820					0.149
4	12900	19370	33310 27600	38880 37920			0.265
5	10320	15490	22080	30330	44810 40260		0.414
6	8600	12910	18400	25280	33550	51690 43410	0.596
7	7370	11070	15770	21670	28760	37210	0.811
8	6450	9680	13800	18960	25160	32560	1.059
9	5730	8610	12270	16850	22370	28940	1.341
10	5160	7750	11040	15170	20130	26050	1.655
11	4690	7040	10040	13790	18300	23680	2.003
12	4300	6460	9200	12640	16780	21710	2.383
13	3970	5960	8490	11670	15480	20040	2.797
14	3690	5530	7890	10830	14380	18610	3.244
15	3440	5160	7360	10110	13420	17360	3.724
16	3220	4840	6900	9480	12580	16280	4.237
17	3030	4560	6500	8920	11840	15320	4.783
18	2870	4300	6130	8430	11180	14470	5.363
19		4080	5810	7980	10590	13710	5.975
20		3870	5520	7580	10070	13020	6.621
21			5260	7220	9590	12400	7.299
22			5020	6890	9150	11840	8.011
23				6590	8750	11320	8.756
24				6320	8390	10850	9.534
25					8050	10420	10.345
26					7740	10020	11.189
27						9650	12.066
28						9300	12.977
29							13.920
30							14.897
31							15.906
32							16.949
33							18.025

DEFLECTION IN CENTER OF SPAN IN INCHES

For loads uniformly distributed over span, $\frac{\text{coefficient}}{\text{depth of beam in inches}}$.

For loads concentrated in center of span, $\frac{4}{5}\times\frac{\text{coefficient}}{\text{depth of beam in inches}}$.

DOUBLE CHANNEL STRUTS

Safe Loads in Pounds, for Direct Loads

Compressive Stresses, $15200-58\frac{l}{r}$ pounds per square inch
for lengths greater than $\frac{l}{r}=55$.
Compressive Stresses, 12000 pounds per square inch
for lengths less than $\frac{l}{r}=55$.

Description of Channels			Unsupported Length in Feet					
Depth	Weight per Ft.	Double Web Thickness	10 and under	12	14	16	18	20
6	8.00	0.400	57120	55290	52450	49600	46760	43920
	10.50	0.636	74160	70480	66570	62650	58740	54830
	13.00	0.880	90810	85740	80680	75610	70550	65490
	15.50	1.126	106890	100540	94190	87840	81500	75150
7	9.75	0.420	68400	68400	66220	63300	60890	57470
	12.25	0.636	86400	86220	82350	78480	74610	70740
	14.75	0.846	104160	102940	98110	93270	88440	83610
	17.25	1.056	121680	119280	113470	107660	101850	96040
	19.75	1.266	139440	135330	128440	121560	114680	107790
8	11.25	0.440	80400	80400	80400	77850	74850	71850
	13.75	0.614	96960	96960	96480	92720	88960	85200
	16.25	0.798	114720	114720	113080	108480	103870	99270
	18.75	0.980	132240	132240	129430	123990	118550	113110
	21.25	1.164	150000	150000	146030	139750	133470	123190
9	13.25	0.460	93360	93360	93360	93430	90330	87230
	15.00	0.576	105840	105840	105840	105180	101570	97960
	20.00	0.904	141120	141120	141120	138080	133000	127910
	25.00	1.230	176400	176400	176400	170630	164030	157430
10	15.00	0.480	107040	107040	107040	107040	106710	103500
	20.00	0.764	141120	141120	141120	141120	138500	134030
	25.00	1.058	176400	176400	176400	176400	171120	165310
	30.00	1.352	211680	211680	211680	210690	203510	196330
	35.00	1.646	246960	246960	246960	244410	235850	227300
12	20.50	0.560	144720	144720	144720	144720	144720	144720
	25.00	0.780	176400	176400	176400	176400	176400	176400
	30.00	1.026	211680	211680	211680	211680	211680	210760
	35.00	1.272	246960	246960	246960	246960	246960	244120
	40.00	1.516	282240	282240	282240	282240	282240	277460
15	33.00	0.800	237600	237600	237600	237600	237600	237600
	35.00	0.852	246960	246960	246960	246960	246960	246960
	40.00	1.048	282240	282240	282240	282240	282240	282240
	45.00	1.244	317760	317760	317760	317760	317760	317760
	50.00	1.440	353040	353040	353040	353040	353040	353040
	55.00	1.636	388320	388320	388320	388320	388320	388320

I-SECTIONS AS BEAMS

Safe Loads in Pounds, for Uniformly Distributed Loads

Bending Stresses, 16000 pounds per square inch

Length of Span, Feet.	12″x5.00″ I 31.5 Lbs.	15″x5.50″ I 42 Lbs.	15″x6.00″ I 60 Lbs.	18″x6.00″ I 55 Lbs.	20″x6.25″ I 65 Lbs.	24″x7.00″ I 80 Lbs.	Coefficients of Deflection.
6	66390 63950		167990 144360				0.596
7	54810	91110 89750	123730				0.811
8	47960	78530	108270				1.059
9	42630	69810	96240	114960 104700			1.341
10	38370	62830	86610	94290	135060 124750		1.655
11	34880	57120	78740	85720	113400		2.003
12	31970	52360	72180	78570	103950		2.383
13	29510	48330	66630	72530	95960		2.797
14	27410	44880	61870	67350	89100	134420 132520	3.244
15	25580	41880	57740	62860	83160	123690	3.724
16	23980	39270	54130	58930	77970	115960	4.237
17	22570	36960	50950	55460	73380	109140	4.783
18	21320	34900	48120	52380	69300	103070	5.363
19	20190	33070	45590	49630	65660	97650	5.975
20	19180	31410	43310	47140	62370	92770	6.621
21	18270	29920	41240	44900	59400	88350	7.299
22	17440	28560	39370	42860	56700	84330	8.011
23	16680	27320	37660	40990	54240	80670	8.756
24	15990	26180	36090	39290	51980	77300	9.534
25	15350	25130	34650	37720	49900	74210	10.345
26	14760	24160	33310	36270	47980	71360	11.189
27	14210	23270	32080	34920	46200	68720	12.066
28	13700	22440	30930	33670	44550	66260	12.977
29	13230	21660	29870	32510	43020	63980	13.920
30	12790	20940	28870	31430	41580	61840	14.897
31		20270	27940	30420	40240	59850	15.906
32		19630	27070	29470	38980	57980	16.949
33		19040	26250	28570	37800	56220	18.025
34				27730	36690	54570	19.134
35				26940	35640	53010	20.276
36					34650	51540	21.451
37					33720	50140	22.659
38						48830	23.901
39						47570	25.175
40						46380	26.483

TABLES FOR PINS AND WEB BEARING

Two Pins required for each Strut

Load on Post Pounds	Distance Between Channels=Flange Width of Beam in Inches																	
	4		4½		5		5½		6		6½		7		7½		8	
	Dia. of Pin	Double Web Thickness Req'd	Dia. of Pin	Double Web Thickness Req'd	Dia. of Pin	Double Web Thickness Req'd	Dia. of Pin	Double Web Thickness Req'd	Dia. of Pin	Double Web Thickness Req'd	Dia. of Pin	Double Web Thickness Req'd	Dia. of Pin	Double Web Thickness Req'd	Dia. of Pin	Double Web Thickness Req'd	Dia. of Pin	Double Web Thickness Req'd
10000	1⅛	.222	1⅛	.222	1⅛	.222	1¼	.200	1¼	.200	1¼	.200	1¼	.200	1⅜	.182	1⅜	.182
20000	1⅜	.364	1⅜	.364	1½	.333	1½	.333	1⅝	.308	1⅝	.308	1⅝	.308	1⅝	.308	1¾	.286
30000	1⅝	.462	1⅝	.462	1⅝	.462	1¾	.429	1¾	.429	1⅞	.400	1⅞	.400	1⅞	.400	2	.375
40000	1¾	.571	1¾	.571	1⅞	.533	1⅞	.533	2	.500	2	.500	2⅛	.471	2⅛	.471	2⅛	.471
50000	1⅞	.667	1⅞	.667	2	.625	2	.625	2⅛	.588	2⅛	.688	2¼	.556	2¼	.556	2⅜	.526
60000	2	.750	2	.750	2⅛	.706	2¼	.667	2¼	.667	2⅜	.632	2⅜	.632	2⅜	.632	2½	.600
70000	2⅛	.824	2⅛	.824	2¼	.778	2¼	.778	2⅜	.737	2⅜	.737	2½	.700	2½	.700	2⅝	.667
80000	2⅛	.941	2¼	.888	2⅜	.842	2⅜	.842	2½	.800	2½	.800	2⅝	.762	2⅝	.762	2¾	.727
90000	2¼	1.000	2⅜	.947	2⅜	.947	2½	.900	2⅝	.857	2⅝	.857	2¾	.818	2¾	.818	2⅞	.783
100000	2⅜	1.053	2⅜	1.053	2½	1.000	2⅝	.953	2⅝	.953	2¾	.909	2⅞	.870	2⅞	.870	3	.833
110000	2⅜	1.158	2½	1.100	2⅝	1.048	2⅝	1.048	2¾	1.000	2⅞	.957	2⅞	.957	3	.917	3	.917
120000	2½	1.200	2⅝	1.143	2⅝	1.143	2¾	1.091	2⅞	1.044	2⅞	1.044	3	1.000	3	1.000	3⅛	.960
130000	2½	1.300	2⅝	1.238	2¾	1.182	2⅞	1.131	2⅞	1.131	3	1.083	3⅛	1.040	3⅛	1.040	3¼	1.000
140000	2⅝	1.333	2¾	1.273	2⅞	1.218	2⅞	1.218	3	1.167	3⅛	1.120	3⅛	1.120	3¼	1.077	3¼	1.077
150000	2⅝	1.429	2¾	1.364	2⅞	1.305	3	1.250	3	1.250	3⅛	1.200	3¼	1.154	3¼	1.154	3⅜	1.111
160000	2¾	1.455	2⅞	1.392	3	1.333	3	1.333	3⅛	1.281	3¼	1.231	3¼	1.231	3⅜	1.185	3½	1.143
170000	2¾	1.546	2⅞	1.478	3	1.418	3⅛	1.362	3¼	1.308	3¼	1.308	3⅜	1.259	3⅜	1.259	3½	1.215
180000	2⅞	1.565	3	1.500	3	1.500	3⅛	1.440	3¼	1.385	3⅜	1.333	3⅜	1.333	3½	1.286	3⅝	1.242
190000	2⅞	1.652	3	1.585	3⅛	1.520	3¼	1.462	3⅜	1.408	3⅜	1.408	3½	1.357	3⅝	1.310	3⅝	1.310
200000	3	1.667	3	1.667	3⅛	1.600	3¼	1.539	3⅜	1.482	3½	1.429	3½	1.429	3⅝	1.380	3¾	1.333

EXAMPLE OF A PIN BEARING GANGWAY SUPPORT.

What will be the size required for a pin bearing gangway support, shown on page 20, for a load of 160,000 pounds uniformly distributed over a span of 9 feet between supporting struts, 16 feet in height, and what will be the deflection of beam?

Answer—Table of safe loads of I sections, page 33; nearest section for given load and span is a 20″ I 80 pounds, the deflection= $\frac{\text{coefficient of deflection}}{\text{depth of beam}}=\frac{1.341}{20}=0.67''$.
Table of pins shown above; the load on post is $\frac{160000}{2}=80000$ pounds and the distance between channels=flange width of 20″ I 80 pounds=7″. Each of the two pins required for the given load and distance is 2⅝″ diameter, bearing 0.762″ on web of channels. Table of Channel Struts, page 34; the nearest channel strut for the given load, web thickness, and height, is one composed of 2-7″[s 14¼ pounds, with a capacity of 93,270 pounds and a double web thickness of 0.846″.

By the use of a larger pin the required web thickness can be correspondingly reduced.

Courtesy Carnegie Steel Co.

WOODEN BEAMS AND POSTS

EXPLANATORY NOTES

Tables of Timber Beams:—The tables give the uniformly distributed safe loads of timber beams for various species of timber and are based upon the following values of maximum unit stresses.

Species of Timber.	Allowable Unit Stresses, in Lbs. per Sq. In.	
	Bending Stresses	Shearing Stresses
Oak	1200 lbs. per square inch	100 lbs. per square inch
Yellow Pine, Long Leaf	1200 “ “ “	70 “ “ “
Yellow Pine, Short Leaf	900 “ “ “	50 “ “ “
White Pine	700 “ “ “	40 “ “ “
Spruce	800 “ “ “	50 “ “ “

The loads given above horizontal lines in tables are the safe loads based upon the extreme shearing stresses given above and should not be exceeded for shorter spans, to avoid failure of beam by shearing.

For loads concentrated in the center of span, use one-half of the uniformly distributed safe load.

Coefficients of Deflection for Timber Beams:—Coefficients are given for maximum uniformly distributed loads based upon the extreme bending stresses given above and upon the following moduli of elasticity, in pounds per square inch:

Oak,	1,500,000	White Pine	1,000,000
Yellow Pine,	1,500,000	Spruce,	1,200,000

The deflection in the center of the span, in inches, is obtained by dividing the coefficient corresponding to the maximum safe load by the depth of the beam in inches.

Safe loads for rectangular timber beams may be obtained from the tables for square timber beams by direct proportion of width to width. The load for a 10"x12" rectangular beam is 5-6 that of a 12"x 12", etc.

Tables of Timber Posts:—The safe loads given in tables are assumed to be centrally applied and are based upon the following compressive unit stresses.

Species of Timber	Compressive Unit Stress, in Lbs. per Sq. in.		
	General Formula	Maximum l/d=10	Minimum l/d=30
Oak	900—17 l/d	730	390
Yellow Pine, Long Leaf	1000—18 l/d	820	460
Yellow Pine, Short Leaf	¾(1000—18 l/d)	615	345
White Pine	800—15 l/d	650	350
Spruce	800—15 l/d	650	350

$\frac{l}{d}$ — $\frac{\text{unsupported length of strut, in inches,}}{\text{least diameter or side, in inches}}$ the allowable ratio of l/d ranging between 10 and 30 equivalent to the maximum and minimum unit stresses given above.

Values given above horizontal lines are the maximum safe loads.

NOTE:—The safe loads given in the tables of timber beams and posts are for seasoned timber only; for green timber use two-thirds of the value shown.

SQUARE TIMBER BEAMS

OAK

Safe Loads in Pounds, for Uniformly Distributed Loads

Length of Span, Feet.	8"x8"	10"x10"	12"x12"	14"x14"	16"x16"	18"x18"	20"x20"	22"x22"	24"x24"
8	8530								
9	7590								
10	6830	13330							
11	6210	12120							
12	5690	11110	19200						
13	5250	10260	17720						
14	4880	9520	16460	26130					
15	4550	8890	15360	24390					
16	4270	8330	14400	22870	34130				
17	4020	7840	13550	21520	32130				
18	3790	7410	12800	20330	30340	43200			
19		7020	12130	19260	28740	40930			
20		6670	11520	18290	27310	38880	53330		
21		6350	10970	17420	26010	37030	50790		
22			10470	16630	24820	35350	48480	64530	
23			10020	15910	23750	33810	46380	61730	
24			9600	15240	22760	32400	44440	59160	76800
25				14640	21850	31100	42670	56790	73730
26				14070	21010	29910	41030	54610	70890
27				13550	20230	28800	39510	52580	68270
28					19510	27770	38100	50700	65830
29					18830	26810	36780	48960	63560
30					18200	25920	35560	47320	61440
31						25080	34410	45800	59460
32						24300	33330	44370	57600
33						23560	32320	43020	55850
34							31370	41760	54210
35							30480	40560	52660
36							29630	39440	51200
37								38370	49820
38								37360	48510
39								36400	47260
40								35490	46080

Courtesy Carnegie Steel Co.

COEFFICIENTS OF DEFLECTION FOR TIMBER BEAMS

Span Feet	Coefficients				Span Feet	Coefficients			
	Oak, Yellow Pine, L. L.	Yellow Pine, S. L.	White Pine	Spruce		Oak, Yellow Pine, L. L.	Yellow Pine, S. L.	White Pine	Spruce
1	0.024	0.018	0.021	0.020	21	10.584	7.938	9.261	8.820
2	0.096	0.072	0.084	0.080	22	11.616	8.712	10.164	9.680
3	0.216	0.162	0.189	0.180	23	12.696	9.522	11.109	10.580
4	0.384	0.288	0.336	0.320	24	13.824	10.368	12.096	11.520
5	0.600	0.450	0.525	0.500	25	15.000	11.250	13.125	12.500
6	0.864	0.648	0.756	0.720	26	16.224	12.168	14.196	13.520
7	1,176	0.882	1.029	0.980	27	17.496	13.122	15.309	14.580
8	1.536	1.152	1.344	1.280	28	18.816	14.112	16.464	15.680
9	1.944	1.458	1.701	1.620	29	20.184	15.138	17.661	16.820
10	2.400	1.800	2.100	2.000	30	21.600	16.200	18.900	18.000
11	2.904	2.178	2.541	2.420	31	23.064	17.298	20.181	19.220
12	3.456	2.592	3.024	2.880	32	24.576	18.432	21.504	20.480
13	4.056	3.042	3.549	3.380	33	26.136	19.602	22.869	21.780
14	4.704	3.528	4.116	3.920	34	27.744	20.808	24.276	23.120
15	5.400	4.050	4.725	4.500	35	29.400	22.050	25.725	24.500
16	6.144	4.608	5.376	5.120	36	31.104	23.328	27.216	25.920
17	6.936	5.202	6.069	5.780	37	32.856	24.642	28.749	27.380
18	7.776	5.832	6.804	6.480	38	34.656	25.992	30.324	28.880
19	8.664	6.498	7.581	7.220	39	36.504	27.378	31.941	30.420
20	9.600	7.200	8.400	8.000	40	38.400	28.800	33.600	32.000

DEFLECTION IN CENTER OF SPAN, IN INCHES

For loads uniformly distributed over span, $\frac{\text{coefficient}}{\text{depth of beam in inches}}$

For loads concentrated in center of span, $\frac{4}{5} \times \frac{\text{coefficient}}{\text{depth of beam in inches}}$

EXAMPLES FOR TIMBER TABLES

I. Required the maximum uniformly distributed safe load of an oak beam, 12" x 12", for a span of 18 feet, and the deflection.

Answer—Table for oak beams, page 38, shows for the given size and span a safe load of 12,800 pounds. The above table shows for this species and span a coefficient of 7.776, which, divided by the depth, 12", gives the deflection of 0.648 inch.

II. Find the size of a round collar, green spruce, to support 5,000 pounds in the center of a span of 14 feet.

Answer—5,000 pounds concentrated in center = 2x5,000 = 10,000 pounds uniformly distributed. 10,000 pounds safe load for green timber = $\frac{3}{2}$x10,000 = 15,000 pounds safe load for seasoned timber. Referring to table for spruce beams, page 47, the nearest size for this load is a 16 inch round.

III. What size square post of long leaf yellow pine, 12 feet long, is required to support a load of 100,000 pounds?

Answer—The table on page 50 shows for the given length and nearest load to 100,000 pounds a size of 12"x12"

ROUND TIMBER BEAMS

OAK

Safe Loads in Pounds, for Uniformly Distributed Loads

Length of Span, Feet	8" Dia.	10" Dia.	12" Dia.	14" Dia.	16" Dia.	18" Dia.	20" Dia.	22" Dia.	24" Dia.
6	6700								
7	5750	11220							
8	5030	9820	16960						
9	4470	8730	15080						
10	4020	7850	13570	21550					
11	3660	7140	12340	19590	29250				
12	3350	6550	11310	17960	26810				
13	3090	6040	10440	16580	24750	38170			
14	2870	5610	9690	15390	22980	32720	44880		
15	2680	5240	9050	14370	21450	30540	41890	55750	
16	2510	4910	8480	13470	20110	28630	39270	52270	67860
17	2370	4620	7980	12680	18920	26940	36960	49190	63870
18	2230	4360	7540	11970	17870	25450	34910	46460	60320
19		4130	7140	11340	16930	24110	33070	44020	57140
20		3930	6790	10780	16090	22900	31420	41820	54140
21		3740	6460	10260	15320	21810	29920	39820	51700
22			6170	9800	14620	20820	28560	38010	49350
23			5900	9370	13990	19920	27320	36360	47210
24			5660	8980	13400	19090	26180	34850	45240
25				8610	12870	18320	25130	33450	43430
26				8290	12370	17620	24170	32170	41760
27				7980	11920	16970	23270	30970	40210
28					11490	16360	22440	29870	38780
29					11090	15800	21670	28840	37440
30					10720	15270	20940	27880	36190
31						14780	20270	26980	35020
32						14310	19640	26130	33930
33						13880	19040	25340	32900
34							18480	24600	31930
35							17950	23890	31020
36							17450	23230	30160
37								22600	29340
38								22010	28570
39								21440	27840
40								20010	27140

SQUARE TIMBER BEAMS

YELLOW PINE, LONG LEAF

Safe Loads in Pounds, for Uniformly Distributed Loads

Length of Span, Feet	8"x8"	10"x10"	12"x12"	14"x14"	16"x16"	18"x18"	20"x20"	22"x22"	24"x24"
12	5970 5690								
13	5250								
14	4880								
15	4550	9330 8890							
16	4270	8330							
17	4020	7840							
18	3790	7410	13440 12800						
19		7020	12130						
20		6670	11520	18290 18290					
21		6350	10970	17420					
22			10470	16630					
23			10020	15910	23880 23750				
24			9600	15240	22760				
25				14640	21850				
26				14070	21010	30240 29910			
27				13550	20230	28800			
28					19510	27770			
29					18830	26810	37330 36780		
30					18200	25920	35560		
31						25080	34410		
32						24300	33330	45170 44370	
33						23560	32320	43020	
34							31370	41760	
35							30480	40560	53760 52660
36							29630	39440	51200
37								38370	49820
38								37360	48510
39								36400	47260
40								35490	46080

ROUND TIMBER BEAMS

YELLOW PINE, LONG LEAF

Safe Loads in Pounds, for Uniformly Distributed Loads

Length of Span, Feet	8" Dia.	10" Dia.	12" Dia.	14" Dia.	16" Dia.	18" Dia.	20" Dia.	22" Dia.	24" Dia.
8	5280 5030								
9	4470								
10	4020	8250 7850							
11	3660	7140							
12	3350	6550	11880 11310						
13	3090	6040	10440						
14	2870	5610	9690	16160 15390					
15	2680	5240	9050	14370					
16	2510	4910	8480	13470	21110 20110				
17	2370	4620	7980	12680	18920				
18	2230	4360	7540	11970	17870	26720 25450			
19		4130	7140	11340	16930	24110			
20		3930	6790	10780	16090	22900	32990 31420		
21		3740	6460	10260	15320	21810	29920	39910 39820	
22			6170	9800	14620	20820	28560	38010	
23			5900	9370	13990	19920	27320	36360	47500 47210
24			5660	8980	13400	19090	26180	34850	45240
25				8620	12870	18320	25130	33450	43430
26				8290	12370	17620	24170	32170	41760
27				7980	11920	16970	23270	30970	40210
28					11490	16360	22440	29870	38780
29					11090	15800	21670	28840	37440
30					10720	15270	20940	27880	36190
31						14780	20270	26980	35020
32						14310	19640	26130	33930
33						13880	19040	25340	32900
34							18480	24600	31930
35							17950	23890	31020
36							17450	23230	30160
37								22600	29340
38								22010	28570
39								21440	27840
40								20910	27140

SQUARE TIMBER BEAMS

YELLOW PINE, SHORT LEAF

Safe Loads in Pounds, for Uniformly Distributed Loads

Length of Span, Feet	8"x8"	10"x10"	12"x12"	14"x14"	16"x16"	18"x18"	20"x20"	22"x22"	24"x24"
12	4270 4270								
13	3940								
14	3660								
15	3410	6670 6670							
16	3200	6250							
17	3010	5880							
18	2840	5560	9600 9600						
19		5260	9100						
20		5000	8640						
21		4760	8230	13070 13070					
22			7860	12470					
23			7510	11930					
24			7200	11430	17070 17070				
25				10980	16380				
26				10550	15750				
27				10170	15170	21600 21600			
28					14630	20830			
29					14120	20110			
30					13650	19440	26670 26670		
31						18810	25810		
32						18230	25000		
33						17670	24240	32270 32270	
34							23530	31320	
35							22860	30420	
36							22220	29580	38400 38400
37								28780	37360
38								28020	36380
39								27300	35450
40								26620	34560

ROUND TIMBER BEAMS

YELLOW PINE, SHORT LEAF

Safe Loads in Pounds, for Uniformly Distributed Loads.

Length of Span, Feet	8" Dia.	10" Dia.	12" Dia.	14" Dia.	16" Dia.	18" Dia.	20" Dia.	22" Dia.	24" Dia.
8	3770 3770								
9	3350								
10	3020	5890 5890							
11	2740	5360							
12	2510	4910	8480 8480						
13	2320	4530	7830						
14	2150	4210	7270	11550 11550					
15	2010	3930	6790	10780					
16	1890	3680	6360	10100	15080 15080				
17	1770	3470	5990	9510	14190				
18	1680	3270	5660	8980	13400	19090 19090			
19		3100	5360	8510	12700	18080			
20		2950	5090	8080	12060	17180	23560 23560		
21		2810	4850	7700	11490	16360	22400		
22			4630	7350	10970	15620	21420	28510 28510	
23			4430	7030	10490	14940	20490	27270	
24			4240	6740	10050	14310	19640	26130	33930 33930
25				6470	9650	13740	18850	25090	32570
26				6220	9280	13210	18130	24120	31320
27				5990	8940	12720	17450	23230	30160
28					8620	12270	16820	22400	29080
29					8320	11850	16250	21630	28080
30					8040	11450	15710	20910	27140
31						11080	15200	20230	26270
32						10740	14730	19600	25450
33						10410	14280	19000	24680
34							13860	18450	23940
35							13460	17920	23270
36							13000	17420	22620
37								16950	22010
38								16510	21480
39								16080	20880
40								15680	[illegible]

Courtesy Carnegie Steel Co.

SQUARE TIMBER BEAMS

WHITE PINE

Safe Loads in Pounds, for Uniformly Distributed Loads

Length of Span, Feet	8"x8"	10"x10"	12"x12"	14"x14"	16"x16"	18"x18"	20"x20"	22"x22"	24"x24"
12	3410 3320								
13	3060								
14	2840								
15	2650	5330 5190							
16	2490	4860							
17	2340	4580							
18	2210	4320	7680 7470						
19		4090	7070						
20		3890	6720						
21		3700	6400	10430 10160					
22			6110	9700					
23			5840	9280					
24			5600	8890	13650 13270				
25				8540	12740				
26				8210	12250				
27				7900	11800	17280 16800			
28					11380	16200			
29					10990	15640			
30					10620	15120	21330 20740		
31						14630	20070		
32						14180	19440		
33						13750	18860	25810 25100	
34							18300	24360	
35							17780	23660	30780 30720
36							17280	23000	29870
37								22380	29060
38								21790	28290
39								21240	27570
40								20700	26880

ROUND TIMBER BEAMS

WHITE PINE

Safe Loads in Pounds, for Uniformly Distributed Loads

Length of Span, Feet	8" Dia.	10" Dia.	12" Dia.	14" Dia.	16" Dia.	18" Dia.	20" Dia.	22" Dia.	24" Dia.
8	3020 2930								
9	2610								
10	2350	4710 4580							
11	2130	4170							
12	1950	3820	6790 6600						
13	1800	3520	6090						
14	1680	3270	5650	9240 8980					
15	1560	3050	5280	8380					
16	1470	2860	4950	7860	12060 11730				
17	1380	2700	4660	7400	11040				
18	1300	2550	4400	6980	10430	15270 14840			
19		2410	4170	6620	9880	14060			
20		2290	3960	6290	9380	13360	18850 18330		
21		2180	3770	5990	8940	12720	17450		
22			3600	5710	8530	12150	16600	22810 22170	
23			3440	5470	8160	11620	15940	21210	
24			3300	5240	7820	11130	15270	20330	27140 26390
25				5030	7510	10690	14660	19510	25330
26				4840	7220	10280	14100	18760	24360
27				4660	69[illegible]0	9900	13570	18070	23400
28					6700	9540	13090	17420	22620
29					6470	9210	12640	16820	21840
30					6260	8910	12220	16260	21110
31						8620	11820	15740	20430
32						8350	11450	15240	19790
33						8100	11110	14780	19190
34							10780	14350	18630
35							10470	13940	18100
36							0180	13550	17590
37								13180	17120
38								12840	16670
39								12510	16240
40								12200	15830

SQUARE TIMBER BEAMS

SPRUCE

Safe Loads in Pounds, for Uniformly Distributed Loads

Length of Span, Feet	8"x8"	10"x10"	12"x12"	14"x14"	16"x16"	18"x18"	20"x20"	22"x22"	24"x24"
11	4270 4140								
12	3790								
13	3500								
14	3250	6670 6350							
15	3030	5930							
16	2840	5560	9600 9600						
17	2680	5230	9040						
18	2530	4940	8530						
19		4680	8080	13070 12840					
20		4440	7680	12200					
21		4230	7310	11610					
22			6980	11090	17070 16550				
23			6680	10600	15840				
24			6400	10170	15170	21600 21600			
25				9760	14560	20740			
26				9380	14000	19940			
27				9030	13480	19200	26670 26340		
28					13000	18510	25390		
29					12550	17880	24520		
30					12130	17280	23700	32370 31550	
31						16720	22940	30530	
32						16200	22220	29580	38400 38400
33						15710	21550	28680	37240
34							20910	27840	36140
35							20320	27040	35110
36							19750	26290	34130
37								25580	33210
38								24910	32340
39								24270	31510
40								23660	30720

Courtesy Carnegie Steel Co.

ROUND TIMBER BEAMS

SPRUCE

Safe Loads in Pounds, for Uniformly Distributed Loads

Length of Span, Feet	8" Dia.	10" Dia.	12" Dia.	14" Dia.	16" Dia.	18" Dia.	20" Dia.	22" Dia.	24" Dia.
8	3770 3350								
9	2980	5890 5820							
10	2680	5240							
11	2440	4760	8480 8230						
12	2230	4360	7540						
13	2060	4030	6960	11550 11050					
14	1920	3740	6460	10260					
15	1790	3490	6030	9580	15080 14300				
16	1680	3270	5650	8980	13400	19090 19090			
17	1580	3080	5320	8450	12620	17960			
18	1490	2910	5000	7980	11920	16960	23560 23270		
19		2760	4760	7560	11290	16070	22050		
20		2620	4520	7180	10720	15270	20940	28510 27880	
21		2490	4310	6840	10210	14540	19850	26550	
22			4110	6530	9750	13880	19040	25340	
23			3930	6250	9330	13280	18210	24240	32930 31470
24			3770	5990	8940	12720	17450	23230	30160
25				5750	8580	12220	16700	22300	28950
26				5530	8250	11750	16110	21440	27840
27				5320	7940	11310	15510	20650	26810
28					7660	10910	14960	19910	25850
29					7400	10530	14440	19230	24960
30					7150	10180	13960	18580	24130
31						9850	13510	17990	23350
32						9540	13100	17420	22620
33						9250	12690	16900	21930
34							12320	16400	21290
35							11970	15930	20680
36							11640	15490	20110
37								15070	19560
38								14670	19050
39								14300	18560
40								13940	18100

SQUARE TIMBER POSTS

OAK

Safe Loads in Pounds, for Direct Loads

Length of Post, Feet	4"x4"	6"x6"	8"x8"	10"x10"	12"x12"	14"x14"	16"x16"	18"x18"	20"x20"
4	11580 11140								
5	10320	26280 26280							
6	9500	25060							
7	8690	23830	46720 46180						
8	7870	22610	44540						
9	7060	21380	42910	73000 71640					
10	6240	20160	41280	69600	105120 105120				
11		18940	39650	67560	102670				
12		17710	38020	65520	100220	143080 142130			
13		16490	36380	63480	97780	139270			
14		15260	34750	61440	95330	136420	186880 184700		
15		14040	33120	59400	92880	133560	181440	234520 236520	
16			31490	57360	90430	130700	178180	232850	
17			29860	55320	87980	127850	174910	229180	292000 290640
18			28220	53280	85540	124990	171650	225500	286560
19			26590	51240	83090	122140	168380	221830	282480
20			24960	49200	80640	119280	165120	218160	278400
22				45120	75740	113570	158590	210820	270240
24				41040	70850	107860	152060	203470	262080
26					65950	102140	145540	196130	253920
28					61060	96430	139010	188780	245760
30					56160	90720	132480	181440	237600

ROUND TIMBER POSTS

OAK

Safe Load in Pounds, for Direct Loads

Length of Post, Feet	4" Dia.	6" Dia	8" Dia.	10" Dia.	12" Dia.	14" Dia.	16" Dia.	18" Dia.	20" Dia.
4	9170 8750								
5	8110	20640 20640							
6	7470	19680							
7	6820	18720	36690 36270						
8	6180	17760	34990						
9	5540	16800	33700	57880 56270					
10	4900	15830	32420	54660	82560 82560				
11		14870	31140	53060	80640				
12		13910	29860	51460	78720	112880 111630			
13		12950	28580	49860	76790	109380			
14		11990	27290	48260	74870	107140	146780 145070		
15		11030	26010	46650	72950	104900	142500	185700 185760	
16			24730	45050	71030	102660	139940	182880	
17			23450	43450	69100	100410	137380	180000	229340 228270
18			22170	41850	67180	98170	134810	177110	225060
19			20890	40240	65260	95930	132250	174230	221860
20			19600	38640	63340	93680	129690	171340	218660
22				35440	59490	89200	124560	165570	212250
24				32230	55640	84710	119430	159810	205840
26					51800	80220	114300	154040	199430
28					47950	75740	109180	148270	193020
30					44110	71250	104050	142500	186610

SQUARE TIMBER POSTS

YELLOW PINE, LONG LEAF

Safe Loads in Pounds, for Direct Loads

Length of Post, Feet	4"x4"	6"x6"	8"x8"	10"x10"	12"x12"	14"x14"	16"x16"	18"x18"	20"x20"
4	[illegible] 12540								
5	11680	29520 29520							
6	10820	28220							
7	9950	26930	[illegible] 51900						
8	9090	25630	50180						
9	8220	24340	48450	82000 80560					
10	7360	23040	46720	78400	[illegible] 118080				
11		21740	44990	76240	115490				
12		20450	43260	74080	112900	160720 159710			
13		19150	41540	71920	110300	156690			
14		17860	39810	69760	107710	153660	209920 207620		
15		16560	38080	67600	105120	150640	204160	265680 265680	
16			36350	65440	102530	147620	200700	261790	
17			34620	63280	99940	144590	197250	257900	328000 326560
18			32900	61120	97340	141570	193790	254020	322240
19			31170	58960	94750	138540	190340	250130	317920
20			29440	56800	92160	135520	186880	246240	313600
22				52480	86980	129470	179970	238460	304960
24				48160	81790	123420	173060	230690	296320
26					76610	117380	166140	222910	287680
28					71420	111330	159230	215140	279040
30					66240	105280	152320	207360	270400

MINING CATALOGUES

ROUND TIMBER POSTS

YELLOW PINE, LONG LEAF

Safe Loads in Pounds, for Direct Loads

Length of Post, Feet	4" Dia.	6" Dia.	8" Dia.	10" Dia.	12" Dia.	14" Dia.	16" Dia.	18" Dia.	20" Dia.
4	10300 9850								
5	9170	23190 23190							
6	8500	22170							
7	7820	21150	41220 40770						
8	7140	20130	39410						
9	6460	19110	38050	64400 63270					
10	5780	18100	36700	61580	92740 92740				
11		17080	35340	59880	90700				
12		16060	33980	58180	88670	126820 125440			
13		15040	32620	56490	86630	123060			
14		14020	31270	54790	84600	120690	164870 163060		
15		13010	29910	53090	82560	118310	160350	208670 208670	
16			28550	51400	80530	115940	157630	205610	
17			27190	49700	78490	113560	154920	202560	257810 256480
18			25840	48000	76450	111190	152200	199500	253090
19			24480	46310	74420	108810	149490	196450	249690
20			23120	44610	72380	106440	146780	193400	246300
22				41220	68310	101690	141350	187200	239520
24				37830	64240	96940	135920	181180	232730
26					60170	92190	130490	175080	225940
28					56100	87440	125060	168970	219160
30					52030	82690	119030	162860	212370

Courtesy Carnegie Steel Co.

SQUARE TIMBER POSTS

. YELLOW PINE, SHORT LEAF

Safe Loads in Pounds, for Direct Loads

Length of Post, Feet	4″x4″	6″x6″	8″x8″	10″x10″	12″x12″	14″x14″	16″x16″	18″x18″	20″x20″
4	9840 9410								
5	8760	22140 22140							
6	8110	21170							
7	7460	20200	39360 38930						
8	6820	19220	37630						
9	6170	18250	36340	61500 60420					
10	5520	17280	35040	58800	88560 88560				
11		16310	33740	57180	86620				
12		15340	32450	55560	84670	120540 119780			
13		14360	31150	53940	82730	117520			
14		13390	29860	52320	80780	115250	157400 155710		
15		12420	28560	50700	78840	112980	153120	199260 199260	
16			27260	49080	76900	110710	150530	196340	
17			25970	47460	74950	108440	147940	193430	246000 244920
18			24670	45840	73010	106180	145340	190510	241680
19			23380	44220	71060	103910	142750	187600	238440
20			22080	42600	69120	101640	140160	184680	235200
22				39360	65230	97100	134980	178850	228720
24				36120	61340	92570	129790	173020	222240
26					57460	88030	124610	167180	215760
28					53570	83500	119420	161350	209280
30					49680	78960	114240	155520	202800

SQUARE TIMBER POSTS.

WHITE PINE, SPRUCE

Safe Loads in Pounds, for Direct Loads

Length of Post, Feet	4″x4″	6″x6″	8″x8″	10″x10″	12″x12″	14″x14″	16″x16″	18″x18″	20″x20″
4	10400 9920								
5	9200	23400 23400							
6	8480	22320							
7	7760	21240	41600 41120						
8	7040	20160	39680						
9	6320	19080	38240	65000 63800					
10	5600	18000	36800	62000	93600 93600				
11		16920	35360	60200	91440				
12		15840	33920	58400	89280	127400 126560			
13		14760	32480	56600	87120	124040			
14		13680	31040	54800	84960	121520	166400 164480		
15		12600	29600	53000	82800	119000	161600	210600 210600	
16			28160	51200	80640	116480	158720	207360	
17			26720	49400	78480	113960	155840	204120	260000 258800
18			25280	47600	76320	111440	152960	200880	255200
19			23840	45800	74160	108920	150080	197640	251600
20			22400	44000	72000	106400	147200	194400	248000
22				40400	67680	101360	141440	187920	240800
24				30800	63360	96320	135680	181440	233600
26					59040	91280	129920	174960	226400
28					54720	86240	124160	168480	219200
30					50400	81200	118400	162000	212000

Courtesy Carnegie Steel Co.

ROUND TIMBER POSTS

YELLOW PINE, SHORT LEAF

Safe Loads in Pounds, for Direct Loads

Length of Post, Feet	4″ Dia.	6″ Dia.	8″ Dia.	10″ Dia.	12″ Dia.	14″ Dia.	16″ Dia.	18″ Dia.	20″ Dia.
4	7730 7390								
5	6880	17390 17390							
6	6370	16630							
7	5860	15860	30910 30570						
8	5350	15100	29560						
9	4850	14340	28540	48300 47450					
10	4340	13570	27520	46180	69550 69550				
11		12810	26500	44910	68030				
12		12050	25490	43640	66500	94670 94080			
13		11280	24470	42370	64970	92300			
14		10520	23450	41090	63450	90520	123650 122300		
15		9760	22430	39820	61920	88730	120260	156500 156500	
16			21410	38550	60390	86950	118230	154210	
17			20400	37280	58870	85170	116190	151920	198210 192360
18			19380	36000	57340	83390	114150	149630	189820
19			18360	34730	55810	81610	112120	147340	187270
20			17340	33460	54290	79830	110080	145050	184730
22				30910	51230	76270	106010	140470	179640
24				28370	48180	72700	101940	135890	174550
26					45130	69140	97870	131310	169460
28					42070	65580	93800	126730	164370
30					39020	62020	89720	122150	159280

ROUND TIMBER POSTS

WHITE PINE, SPRUCE

Safe Loads in Pounds, for Direct Loads

Length of Post, Feet	4″ Dia.	6″ Dia.	8″ Dia.	10″ Dia.	12″ Dia.	14″ Dia.	16″ Dia.	18″ Dia.	20″ Dia.
4	8170 7790								
5	7230	18380 18380							
6	6660	17530							
7	6100	16680	32670 32300						
8	5530	15830	31170						
9	4960	14990	30030	51050 50110					
10	4400	14140	28900	48700	73510 73510				
11		13290	27770	47280	71820				
12		12440	26640	45870	70120	106060 99400			
13		11590	25510	44450	68420	97420			
14		10740	24380	43040	66730	95440	130690 129180		
15		9900	23250	41630	65030	93460	126920	165410 165410	
16			22120	40210	63340	91480	124660	162860	
17			20990	38800	61640	89500	122400	160320	204300 203260
18			19860	37390	59940	87530	120140	157770	200430
19			18720	35970	58250	85550	117870	155230	197610
20			17590	34560	56550	83570	115610	152680	194780
22				31730	53160	79610	111090	147590	189120
24				28900	49760	75650	106560	142500	183470
26					46370	71690	102040	137410	177820
28					42980	67730	97520	132320	172160
30					39580	63780	92990	127240	166510

BOARD MEASURE

Number of Board Feet Per Lineal Foot for Various Widths and Thicknesses.

Width of Board, In.	Thickness of Board, Inches											
	1	1½	2	2½	3	3½	4	5	6	7	8	9	10
3	0 250	0.375	0.500	0.625	0 750	......	......	......	......	......	......	......	......
3½	.292	.438	.583	.729	.875	1.021	......	......	......	......	......	......	......
4	333	500	.667	.833	1 000	1 167	1.333	......	......	......	......	......	......
4½	375	563	.750	938	1.125	1.313	1.500	......	......	......	......	......	......
5	.417	.625	.833	1.042	1.250	1.457	1.666	2.083	......	......	......	......	......
6	.500	750	1 300	1.250	1 500	1.750	2.000	2.500	3.000	......	......	......	......
7	583	875	1.167	1 458	1.750	2.042	2.333	2.917	3.500	4.083	......	......	......
8	667	1 000	1 333	1 667	2 000	2.333	2.667	3.333	4.000	4.667	5.333	......	......
9	750	1 125	1 500	1.875	2.250	2.625	3.000	3.750	4.500	5.250	6.000	6.750	......
10	.833	1.250	1 667	2.083	2.500	2.917	3.333	4.167	5.000	5.833	6.667	7.500	8.333
11	917	1.375	1 833	2.292	2.750	3.208	3.667	4.583	5.500	6.417	7.333	8.250	9.167
12	1.000	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000	7.000	8.000	9.000	10.00
13	1.083	1 625	2.167	2.708	3.250	3.792	4.333	5.417	6 500	7.583	8.667	9.750	10.83
14	1 167	1.750	2.333	2.917	3.500	4.083	4.667	5.833	7.000	8.167	9.333	10.50	11.67
15	1.250	1 875	2.500	3.125	3.750	4.375	5.000	6.250	7.500	8.750	10.00	11.25	12.50
16	1 333	2.000	2.667	3.333	4.000	4.667	5.333	6.667	8.000	9.333	10.67	12.00	13.33
18	1 500	2.250	3.000	3,750	4.500	5.250	6.000	7.500	9.000	10.50	12.00	13.50	15.00
20	1 667	2 500	3 333	4.167	5.000	5.833	6.667	8.333	10.00	11.67	13.33	15.00	16.67

LUMBER TABLE

For convenience the number of Board Feet in Single Pieces of the Commercial Sizes are given below.

Size in inches	LENGTHS IN FEET							
	10	12	13	14	16	18	20	22
1 x 2	1⅔	2	2⅙	2⅓	2⅔	3	3⅓	3⅔
1 x 3	2½	3	3¼	3½	4	4½	5	5½
1 x 3½	2 11/12	3½	3 19/24	4 1/12	4⅔	5¼	5⅚	6 5/12
1 x 4	3⅓	4	4⅓	4⅔	5⅓	6	6⅔	7⅓
1 x 5	4⅙	5	5 5/12	5⅚	6⅔	7½	8⅓	9⅙
1 x 6	5	6	6½	7	8	9	10	11
1 x 8	6⅔	8	8⅔	9⅓	10⅔	12	13⅓	14⅔
1 x 9	7½	9	9¾	10½	12	13½	15	16½
1 x 10	8⅓	10	10⅚	11⅔	13⅓	15	16⅔	18⅓
1 x 12	10	12	13	14	16	18	20	22
1 x 13	10⅚	13	14 1/12	15⅙	17⅓	19½	21⅔	23⅚
1 x 14	11⅔	14	15⅙	16⅓	18⅔	21	23⅓	25⅔
1¼ x 3	3⅛	3¾	4 1/16	4⅜	5	5⅝	6¼	6⅞
1¼ x 4	4⅙	5	5 5/12	5⅚	6⅔	7½	8⅓	9⅙
1¼ x 5	5 5/24	6¼	6 37/48	7 7/24	8⅓	9⅜	10 5/12	11 11/24
1¼ x 6	6¼	7½	8⅛	8¾	10	11¼	12½	13¾
1¼ x 8	8⅓	10	10⅚	11⅔	13⅓	15	16⅔	18⅓
1¼ x 9	9⅜	11¼	12 3/16	13⅛	15	16⅞	18¾	20⅝
1¼ x 10	10 5/12	12½	13 13/24	14 7/12	16⅔	18¾	20⅚	22 11/12
1¼ x 12	12½	15	16¼	17½	20	22½	25	27½
2 x 3	5	6	6½	7	8	9	10	11
2 x 4	6⅔	8	8⅔	9⅓	10⅔	12	13⅓	14⅔
2 x 9	15	18	19½	21	24	27	30	33
2 x 10	16⅔	20	21⅔	23⅓	26⅔	30	33⅓	36⅔
4 x 4	13⅓	16	17⅓	18⅔	21⅓	24	26⅔	29⅓
5 x 5	20⅚	25	27 1/12	29⅙	33⅓	37½	41⅔	45⅚
6 x 6	30	36	39	42	48	54	60	66
8 x 8	53⅓	64	69⅓	74⅔	85⅓	96	106⅔	117⅓
8 x 10	66⅔	80	96⅔	93⅓	106⅔	120	133⅓	149⅔

DECIMAL OF AN INCH AND OF A FOOT

Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions
	.0052	1/16		.2552	3 1/16		.5052	6 1/16		.7552	9 1/16
	.0104	⅛		.2604	3⅛		.5104	6⅛		.7604	9⅛
1/64	.015625	3/16	17/64	.265625	3 3/16	33/64	.515625	6 3/16	49/64	.765625	9 3/16
	.0208	¼		.2708	3¼		.5208	6¼		.7708	9¼
	.0260	5/16		.2760	3 5/16		.5260	6 5/16		.7760	9 5/16
1/32	.03125	⅜	9/32	.28125	3⅜	17/32	.53125	6⅜	25/32	.78125	9⅜
	.0365	7/16		.2865	3 7/16		.5365	6 7/16		.7865	9 7/16
	.0417	½		.2917	3½		.5417	6½		.7917	9½
3/64	.046875	9/16	19/64	.296875	3 9/16	35/64	.546875	6 9/16	51/64	.796875	9 9/16
	.0521	⅝		.3021	3⅝		.5521	6⅝		.8021	9⅝
	.0573	11/16		.3073	3 11/16		.5573	6 11/16		.8073	9 11/16
1/16	.0625	¾	5/16	.3125	3¾	9/16	.5625	6¾	13/16	.8125	9¾
	.0677	13/16		.3177	3 13/16		.5677	6 13/16		.8177	9 13/16
	.0729	⅞		.3229	3⅞		.5729	6⅞		.8229	9⅞
5/64	.078125	15/16	21/64	.328125	3 15/16	37/64	.578125	6 15/16	53/64	.828125	9 15/16
	.0833	1		.3333	4		.5833	7		.8333	10
	.0885	1 1/16		.3385	4 1/16		.5885	7 1/16		.8385	10 1/16
3/32	.09375	1⅛	11/32	.34375	4⅛	19/32	.59375	7⅛	27/32	.84375	10⅛
	.0990	1 3/16		.3490	4 3/16		.5990	7 3/16		.8490	10 3/16
	.1042	1¼		.3542	4¼		.6042	7¼		.8542	10¼
7/64	.109375	1 5/16	23/64	.359375	4 5/16	39/64	.609375	7 5/16	55/64	.859375	10 5/16
	.1146	1⅜		.3646	4⅜		.6146	7⅜		.8646	10⅜
	.1198	1 7/16		.3698	4 7/16		.6198	7 7/16		.8698	10 7/16
⅛	.1250	1½	⅜	.3750	4½	⅝	.6250	7½	⅞	.8750	10½
	.1302,	1 9/16		.3802	4 9/16		.6302	7 9/16		.8802	10 9/16
	.1354	1⅝		.3854	4⅝		.6354	7⅝		.8854	10⅝
9/64	.140625	1 11/16	25/64	.390625	4 11/16	41/64	.640625	7 11/16	57/64	.890625	10 11/16
	.1458	1¾		.3958	4¾		.6458	7¾		.8958	10¾
	.1510	1 13/16		.4010	4 13/16		.6510	7 13/16		.9010	10 13/16
5/32	.15625	1⅞	13/32	.40625	4⅞	21/32	.65625	7⅞	29/32	.90625	10⅞
	.1615	1 15/16		.4115	4 15/16		.6615	7 15/16		.9115	10 15/16
	.1667	2		.4167	5		.6667	8		.9167	11
11/64	.171875	2 1/16	27/64	.421875	5 1/16	43/64	.671875	8 1/16	59/64	.921875	11 1/16
	.1771	2⅛		.4271	5⅛		.6771	8⅛		.9271	11⅛
	.1823	2 3/16		.4323	5 3/16		.6823	8 3/16		.9323	11 3/16
3/16	.1875	2¼	7/16	.4375	5¼	11/16	.6875	8¼	15/16	.9375	11¼
	.1927	2 5/16		.4427	5 5/16		.6927	8 5/16		.9427	11 5/16
	.1979	2⅜		.4479	5⅜		.6979	8⅜		.9479	11⅜
13/64	.203125	2 7/16	29/64	.453125	5 7/16	45/64	.703125	8 7/16	61/64	.953125	11 7/16
	.2083	2½		.4583	5½		.7083	8½		.9583	11½
	.2135	2 9/16		.4635	5 9/16		.7135	8 9/16		.9635	11 9/16
7/32	.21875	2⅝	15/32	.46875	5⅝	23/32	.71875	8⅝	31/32	.96875	11⅝
	.2240	2 11/16		.4740	5 11/16		.7240	8 11/16		.9740	11 11/16
	.2292	2¾		.4792	5¾		.7292	8¾		.9792	11¾
15/64	.234375	2 13/16	31/64	.484375	5 13/16	47/64	.734375	8 13/16	63/64	.984375	11 13/16
	.2396	2⅞		.4896	5⅞		.7396	8⅞		.9896	11⅞
	.2448	2 15/16		.4948	5 15/16		.7448	8 15/16		.9948	11 15/16
¼	.2500	3	½	.5000	6	¾	.7500	9	1	1.0000	12

SPECIFIC GRAVITY AND WEIGHT OF WOOD

	Gravity Specific	Average Specific Gravity	Weight per Cubic Foot Pounds
Alder	0.56 to 0.80	0.68	42
Apple	.73 to .79	.76	47
Ash	.60 to .84	.72	45
Bamboo	.31 to .40	.35	22
Beech	.62 to .85	.73	46
Birch	.56 to .74	.65	41
Box	.91 to 1.33	1.12	70
Cedar	.49 to .75	.62	39
Cherry	.61 to .72	.66	41
Chestnut	.46 to .66	.56	35
Cork	.24 to ...	.24	15
Cypress	.41 to .66	.53	33
Dogwood	.76 to ...	.76	47
Ebony	1.13 to 1.33	1.23	76
Elm	.55 to .78	.61	38
Fir	.48 to .70	.59	37
Gum	.84 to 1.00	.92	57
Hackmatack	.59 to ...	.59	37
Hemlock	.36 to .41	.38	24
Hickory	.69 to .94	.77	48
Holly	.76 to ...	.76	47
Hornbeam	.76 to ...	.76	47
Juniper	.56 to ...	.56	35
Larch	.56 to ...	.56	35
Lignum Vitae	.65 to 1.33	1.00	62
Linden	.604 to ...	...	37
Locust	.728 to ...	...	46
Mahogany	.56 to 1.06	.81	51
Maple	.57 to .79	.68	42
Mulberry	.56 to .90	.73	46
Oak, Live	.96 to 1.26	1.11	69
Oak, White	.69 to .86	.77	48
Oak, Red	.73 to .75	.74	46
Pine, White	.35 to .55	.45	28
Pine, Yellow	.46 to .76	.61	38
Poplar	.38 to .58	.48	30
Spruce	.40 to .50	.45	28
Sycamore	.59 to .62	.60	37
Teak	.66 to .98	.82	51
Walnut	.50 to .67	.58	36
Willow	.49 to .59	.54	34

WORKING UNIT STRESSES FOR STRUCTURAL TIMBER

ADOPTED BY THE AMERICAN RAILWAY ENGINEERING ASSOCIATION

The working unit stresses given in the table are intended for railroad bridges and trestles. For highway bridges and trestles, the unit stresses may be increased 25 per cent. For buildings and similar structures, in which the timber is protected from the weather and practically free from impact, the unit stresses may be increased 50 per cent. To compute the deflection of a beam under long continued loading instead of that when the load is first applied, only 50 per cent. of the corresponding modulus of elasticity given in the table is to be employed.

Kind of Timber	Unit Stresses in Pounds per Square Inch												
	Bending			Shearing				Compression					
	Extreme Fiber Stress		Modulus of Elasticity	Parallel to the Grain		Longitudinal Shear in Beams		Perpendicular to the Grain		Parallel to the Grain		Working Stresses for Columns	
	Average Ultimate	Working Stress	Average	Average Ultimate	Working Stress	Average Ultimate	Working Stress	Elastic Limit	Working Stress	Average Ultimate	Working Stress	Length under 15 x d	Length over 15 x d
Douglas Fir	6100	1200	1510000	690	170	270	110	630	310	3600	1200	900	1200(1—l/60d)
Longleaf Pine	6500	1300	1610000	720	180	300	120	520	260	3800	1300	975	1300(1—l/60d)
Shortleaf Pine	5600	1100	1480000	710	170	330	130	340	170	3400	1100	825	1100(1—l/60d)
White Pine	4400	900	1130000	400	100	180	70	290	150	3000	1000	750	1000(1—l/60d)
Spruce	4800	1000	1310000	600	150	170	70	370	180	3200	1100	825	1100(1—l/60d)
Norway Pine	4200	800	1190000	590*	130	250	100		150	2600*	800	600	800(1—l/60d)
Tamarack	4600	900	1220000	670	170	260	100		220	3200*	1000	750	1000(1—l/60d)
Western Hemlock	5800	1100	1480000	630	160	270*	100	440	220	3500	1200	900	1200(1—l/60d)
Redwood	5000	900	800000	300	80			400	150	3300	900	675	900(1—l/60d)
Bald Cypress	4800	900	1150000	500	120			340	170	3900	1100	825	1100(1—l/60d)
Red Cedar	4200	800	800000					470	230	2800	900	675	900(1—l/60d)
White Oak	5700	1100	1150000	840	210	270	110	920	450	3500	1300	975	1300(1—l/60d)

Unit stresses are for green timber and are to be used without increasing the live load stresses for impact. Values noted* are for partially air dry timbers.

In the formulas given for columns, l=length of column, in inches, and d=least side or diameter, in inches.

STRENGTH OF MATERIALS

STRESSES IN POUNDS PER SQUARE INCH

Building Materials	Ultimate Average Stresses			Modulus of Elasticity	Safe Working Stresses		
	Compress.	Tension	Bending		Compress.	Bearing	Shearing
Stone							
Bluestone	12,000	1,200	2,500	7,000,000	1,200	1,200	200
Granite, gneiss	12,000	1,200	1,600	7,000,000	1,200	1,200	200
Limestone, marble	8,000	800	1,500	7,000,000	800	800	150
Sandstone	5,000	150	1,200	3,000,000	500	500	150
Slate	10,000	3,000	5,000	14,000,000	1,000	1,000	175
Brick							
Common, good	10,000	200	600				
" medium burned	11,000						
" hard burned	15,000						
Pressed and paving	6,000						
Cement, Portland							
Neat, 28 days	7,040	740					
" 90 days	7,350	740					
1:3 sand, 28 days	1,290	320					
" 90 days	1,490	340					
Concrete, P. C.							
1:1½:3, hard stone	2,650						
" soft stone	1,800						
" cinders	700						
1: 2 :4, hard stone	2,100						
" soft stone	1,500						
" cinders	600						
1:2½:5, hard stone	1,700						
" soft stone	1,200						
" cinders	500						
1: 3 :6, hard stone	1,350						
" soft stone	1,000						
" cinders	400						
Masonry							
Granite					420	600	
Limestone, bluestone					350	500	
Sandstone					280	400	
Rubble					140	250	
" coursed					168	250	
Concrete, P. C., 1: 2 :4					350	600	
" " 1:2½:5					280	500	
Brick, common					168	300	
" hard burned					210	300	
Miscellaneous							
Glass, common	30,000	3,000	3,000	8,000,000			
" flooring	10,000	3,000	3,000				
Plaster	700	70					
Terra cotta	5,000						
Ropes, cast steel hoisting		80,000					
" standing, derrick		70,000					
" manila		8,000					
Belts, solid woven, cotton		7,800					
" " " flax		9,900					

Reinforced Concrete—Safe Working Stresses*

Elastic Modulus	2,000,000 if ult. compression is up to 2,200. 2,500,000 if ult. compression is over 2,200. 3,000,000 if ult. compression is over 2,900.
Compression	22.5% of ult. compression on piers or columns of lengths not exceeding 12 dia.
Bearing	32.5% of ult. compression on surfaces of at least twice the loaded area.
Shearing	2.0% of ult. compression, horizontal bars. 3.0% for reinforcement with bent-up bars. 6.0% for thoroughly reinforced webs.
Bond	4% of ult. compression for plain bars. 2% for drawn wire.

For ultimate and working stresses of Structural Timber, see page 319.

*For complete data, see Proceedings of the American Society of Civil Engineers, Vol. XXXIX, No. 2, February, 1913.

STRENGTH OF MATERIALS

STRESSES PER SQUARE INCH

Metals and Alloys	Stresses in Thousands of Pounds					Modulus of Elasticity, Pounds	Elongation, %	Reduction of Area, %
	Tension, Ultimate	Elastic Limit	Compression, Ultimate	Bending, Ultimate	Shearing, Ultimate			
Steel								
Structural Shapes, plates*								
" bridges	60	½ tens.	tensile	tensile	¾ tens.	29,000,000	25	
" buildings	55-65	"	"	"	"	29,000,000	25-21	
" ships	55-65	"	"	"	"	29,000,000	27-23	
Boiler Plates*								
" " flange	55-65	½ tens.	tensile	tensile	¾ tens.	29,000,000	27-23	
" " fire box	52-62	"	"	"	"	29,000,000	29-24	
" " extra soft	45-55	"	"	"	"	29,000,000	33-27	
Rivets*								
" bridges	50	½ tens	tensile	tensile	¾ tens.	29,000,000	30	
" buildings, ships	48-58	"	"	"	"	29,000,000	29-24	
Reinforcement Bars**								
" structural, plain	55-70	33	tensile	tensile	¾ tens.	29,000,000	25-20	
" " deformed	55-70	33	"	"	"	29,000,000	22-18	
" hard, plain	80 min.	50	"	"	"	29,000,000	15	
" " deformed	60 min.	50	"	"	"	29,000,000	12.5	
" cold twisted		55	"	"	"	29,000,000	5	
Castings*								
" bridges	65	½ tens.	tensile	tensile	¾ tens.		18	
" ships	60	"	"	"	"		18	
Forgings*								
" soft, low carbon	58	29	tensile	tensile	¾ tens.		28	28
" carbon, not annealed	75	37.5	"	"	"		18	30
" " annealed	70-80	35-40	"	"	"		24-22	30-35
" " oil tempered	80-90	45-55	"	"	"		23-20	40-45
" locomotive	80	40	"	"	"		20	25
" nickel, annealed	80	45-50	"	"	"		24-25	40-45
" " oil tempered	85-95	55-65	"	"	"		24-21	45-50
" axles, carbon steel	80	40	"	"	"		20	25
" " nickel	80	50	"	"	"		25	45
Steel Alloys								
Nickel Steel, 3—4% Ni								
" shapes, plates	80 min.	50 min.	tensile	tensile	¾ tens.		20	
" rivets	70-85	45 min.	"	"	"		23-19	
Copper Steel, 0.5% Cu	60-68	37-38	"	"	"		23-29	48-53
Steel Springs and Wire								
Springs, untempered	65-115	40-70						
Wire, unannealed	120	60						
" annealed	80	40						
" bridge cable	200	95						
Wrought Iron								
Shapes	48	26	tensile	tensile	5/6 tens	28,000,000		
Bars	50	27	"	"	"	28,000,000		
Wire, unannealed	80					15,000,000		
" annealed	60	27				25,000,000		
Cast Iron								
Common	15-18	6	80	30	18-20	12,000,000		
Gray	18-24			25-33				
Malleable	27-35	15-20	46	30	40			

*See Specifications of the Society of Testing Materials, adopted August 16, 1909.

**See Specifications of the Association of American Manufacturers, adopted 1910.

Stone Work

Stone walls are measured by the perch (24¾ cubic feet). Openings less than 3 feet wide are counted solid; over 3 feet are deducted, but 18 inches are added to the running measure for each jamb built. Arches are counted solid from their spring. Corners of buildings are measured twice. Pillars less than 3 feet are counted on three sides as lineal, multiplied by fourth side and depth.

It is customary to measure all foundation and dimension stone by the cubic foot. Water tables and base courses by lineal feet. All sills and lintels or ashlar, by superficial feet, and no walls less than 18 inches thick.

The greatest safe load per super. foot on:—

Granite piers	equals	40 tons.
Limestone piers	"	25 "
Sandstone piers	"	15 "
Brickwork in cement	"	3 "
Rubble masonry	"	2 "
Lime Concrete foundations	"	2½"

The height of brick or stone piers should not exceed twelve times their least thickness at base.

Brick Work

Brick work is generally measured by 1000 brick laid in the wall. In consequence of variations in size of bricks, no rule for volume of brick can be exact. The following scale is, however, a fair average:

7 bricks to a super. foot	4″ wall	equals	40 lbs.
14 " " "	9″ "	"	94 "
21 " " "	13″ "	"	121 "
28 " " "	18″ "	"	168 "
35 " " "	22″ "	"	210 "

Corners are not measured twice as in stone work. Openings over 2 feet square are deducted. Arches are counted from the spring. Fancy work counted 1½ bricks for 1. Pillars are measured on their face only.

A cubic yard of mortar requires 1 cubic yard of sand and 9 bushels of lime, and will fill 30 hods.

One thousand bricks, closely stacked, occupy about 56 cubic feet.

One thousand old bricks, cleaned and loosely stacked, occupy about 72 cubic feet.

One superficial foot of gauged arches requires 10 bricks.

Stock bricks commonly measure 8¾ inches by 4¼ inches by 2¼ inches and weigh from 5 to 6 pounds each.

Paving bricks should measure 9 inches by 4½ inches by 1¾ inches, and weigh about 4½ pounds each.

One yard of paving requires 36 stock bricks, of above dimensions, laid flat, or 52 on edge; and 35 paving brick laid flat, or 82 on edge.

Courtesy Waverly Oil Works Co.

Concrete in Mine Construction

†By H. Colin Campbell.

Increasing scarcity of timber of dimensions suitable for the usual requirements of underground mine construction has, for some years, been a serious problem. This has led to the use of concrete in various ways for many of the requirements heretofore met by timber. Concrete is now being used for lining and fireproofing old frame structures inside and outside the mine, fireproofing and rustproofing structural steel, building stopping, sealing loose rock, waterproofing surfaces which disintegrate under the action of moist air, and in the form of pre-cast units is serving as mine "timber."

Not the least important of the many distinctive advantages possessed by concrete in mine work is the security afforded against fire, which is a constant menace in coal mining. Permanence, which concrete construction expresses in the greatest degree, does away also with the continual maintenance expense necessary to replace timbering which under most mine conditions is short lived.

In a paper by A. F. Allard, chief engineer of the Bunsen Coal Co., Danville, Illinois, will be found a summary of practice in the use of concrete in the mines of Bunsen Coal Co. Mr. Allard is a strong advocate of concrete in mine work. To quote him partly:

> "As a fireproof and permanent material for the lining of shaft walls, concrete is without a rival, and its adaptability for this class of work is well recognized; judging by the large number of concrete shafts, now being constructed. In fact, we have hoisting and ventilating shafts completed from top to bottom without a piece of timber, the lining walls, cross-buntons, and division wall of the air compartment are of concrete, with the guides and stairways of steel. The method of sinking mine shafts by means of the concrete caisson with a steel cutting edge or shoe, through soft and water bearing strata has come into prominent use, for by its weight, penetration to a great depth is possible, rapid sinking progress is made, the flow of water met with is reduced and a great saving in cost of labor and material is obtained by the omission of timber curbing.
>
> From comparative cost data, I find that price per vertical floor of completed concrete lined shaft to be about one-third more than that of the wooden structure; this amount is in the first cost only, for after a few years' time, renewal of timbers would be necessary in the latter."

In the limited space at our disposal it is impossible to cite the numerous instances where concrete is now replacing timber in underground mine workings. One of the most notable and recent instances is that of the Oliver Iron Mining Co., on the Missabe Iron Range, where five shafts, constructed last summer, are lined with concrete sets, while five power plants to operate the shafts are being constructed of concrete block. This work was described in "Engineering Record" for October 31, 1914, reproductions of photographs and drawings illustrating the application of concrete in this particular instance. The experience of the Oliver Iron Mining Co. discloses that timber shaft lining soon decays, and that after 4 or 5 years, shafts so lined require continual and heavy maintenance expenditures, so designs were worked out to substitute concrete mine "timbers" in place of wood. Shaft members were cast in steel forms to shapes of exactly the same dimensions of timber sets for the same size of shaft, thus making unnecessary any changes in the various standards of equipment previously worked out and already in use.

Cement-concrete has been applied in mine workings, especially in shafts, to protect timber and steel construction against fire. A notable instance of this is the Cary Mine, for the Odanah Iron Co., (Pickands-Mather Co., Cleveland, Ohio) which has recently fireproofed the steel members of one of its shafts by applying a protective cement-concrete covering by means of an apparatus known as the "Cement-Gun," which is also used largely in shooting cement into rock seams for the purpose of sealing loose rock and for waterproofing surfaces. In the Cary Mine the entire interior of the shaft was covered with wire mash over which a 2-inch coating of "Gunite" was placed.* The steel work was covered with a galvanized wire netting and a ¾-inch coating of "Gunite" then applied. By this process the shaft has been made fireproof.

That such practices should receive increased attention from mine operators and owners is apparent when one realizes that in case of mine accidents the shaft must be of permanent construction so that it may be relied upon. No matter what may happen to the mine the shaft should be safe against the ravages of fire. It is also apparent that the mine shaft should be waterproof because in a dry shaft the deterioration of steel and woodwork, cages, etc., is greatly reduced and the operation of the shaft is not only made considerably safer but more economical.

Cement coatings applied as just suggested should consist of a 1:3 mixture in which the sand is clean, well graded from coarse to fine, and free from organic or other foreign matter such as clay, etc. Full details of the work of the Cary mine are given in an article in the "Engineering and Mining Journal" for February 27, 1915.

Another interesting paper on the use of concrete in mine work will be found in the Proceedings of the Lake Superior Mining Institute, Vol. 18, and refers to the relining of a shaft at the Chapin Mine, Iron Mountain, Michigan.

Of course, concrete has been used in various other ways in underground mine workings. Concrete has been, and is at the present time, used to an increasing extent in building underground dams and bulkheads, and as in above-ground usuages, has given a good account of itself. In most localities where concrete would be practicable all of the necessary materials are near at hand, or may be readily obtained, another reason for giving preference to concrete.

To obtain success with concrete in any construction, careful attention must be given to selecting and proportioning the materials used with the cement. Sand, and gravel or broken stone are commonly referred to as "aggregates," sand being known as "fine aggregate" and gravel or broken stone as "coarse aggregate." Aggregates must be clean coarse, hard and well-graded. Any coating or film of foreign matter covering the particles will effectively prevent good bond of the cement on and between their surfaces. Aggregates must be coarse because the coarser aggregate presents the smaller relative surface for the same volume, and is also more easily covered with cement and makes a stronger concrete with the same proportion of cement.

A prime requisite in proportioning and mixing concrete is that fine and coarse aggregates shall be kept separate and recombined at the time of proportioning each batch, in definite quantities. A 1:2:4 mixture does not mean, nor is not in any way like, a 1:6 mixture in which the 6 parts represent a volume of natural bank-run or pit-run gravel. Bank-run gravel does not occur in the proper proportions of fine or coarse materials and to secure the maximum density, hence strength and watertightness of concrete, mixtures must be so proportioned that voids shall be reduced to the least possible percentage of the total volume.

*Gunite is a mixture of good sharp sand and Portland cement mixed dry, shot by means of the Cement-Gun with an air pressure of about 35 pounds per square inch, the water being added in the nozzle at the moment the mixture emerges. It is fire and waterproof. It can be applied to old mines as well as new and the work can be done with very little interruption of hoisting.

†With Portland Cement Association.

Particles of aggregate which will pass a ¼-inch screen (one having 4 meshes per lineal inch) are considered as sand; coarse aggregate, either screened gravel or crushed stone, shall all be coarser than ¼-inch, and for ordinary work the maximum diameter should not exceed 1½ inches. One sack of Portland cement (94 pounds net) is considered 1 cubic foot, and each batch of concrete should be some multiple of 1 sack. A 1:2:4 mixture, therefore, means 1 sack of Portland cement, 2 cubic feet of sand, and 4 cubic feet of gravel or broken stone; sand and gravel to conform as regards size, grading and cleanliness, to the specifications already given.

Water used in mixing concrete should also be clean and free from organic matter. The amount required depends largely upon the character of the work to be done. Wherever possible, it is desirable to mix concrete to a "quaky" consistency, so that the mass will readily settle into all parts of the forms in which it is being placed, with a minimum amount of puddling or tamping. If too much water is used the cement-sand mortar will separate from the coarse aggregate. Also, if the forms are not watertight, water will flow out and carry a good deal of cement with it, thus robbing the concrete of its most vital constituent.

The following mixtures are recommended for various types of concrete work:

CONCRETE.

A 1:2:3 mixture for:

- One-course concrete walks and pavements.
- One-course floors.
- Roofs.
- Fence posts, mine timbers, and sills, and lintels without mortar surface.
- Water troughs and tanks.

1:2:4 mixture for:

- Reinforced concrete floors, beams and columns.
- Large engine foundations.
- Work exposed to vibration.

1:2½:4 mixture for:

- Building walls and foundations of underground workings.
- Backing of concrete block and similar cement products.

1:2½:5 mixture for:

- Basement walls and foundations of above ground structures.
- Small engine foundations.
- Base of sidewalks and two-course floors.

1:3:5 mixture for:

- Mass concrete footings.

MORTAR.

1-1 mixture for:

- Facing water tanks.

1-1½ mixture for:

- Wearing course of two-course floors.

1-2 mixture for:

- Scratch coat of exterior plaster.
- Facing blocks and similar cement products.
- Wearing course of two-course walks, street and highway pavements.

1-2½ mixture for:

- Finish coat, exterior plaster.
- Fence posts, when coarse aggregate is not used.

1-3 mixture for:

- Concrete blocks when coarse aggregate is not used.
- Cement drain tile, when coarse aggaregate is not used.

Quantities of sand and gravel or stone requird for a one-bag batch or mortar or concrete, and volume of resulting compacted mortar or concrete.

MIXTURES.			MATERIALS.			VOL. IN CU. FT.	
Cem.	Sand	Grav. or Stone	Cem. in Sacks	Sand Cu. Ft.	Grav. or Stone Cu. Ft.	Mortar	Concrete
1	1.5	..	1	1.5	....	1.75	..
1	2	..	1	2.0	..	2.1	..
1	2.5	..	1	2.5	..	2.5	..
1	3	..	1	3.0	..	2.8	..
1	2	3	1	2	3	..	3.9
1	2	4	1	2	4	..	4.5
1	2.5	4	1	2.5	4	..	4.8
1	3	5	1	3	5	..	5.8

Quantities of cement, sand and gravel or stone required for one cubic yard of compacted mortar or concrete.

MIXTURES.			QUANTITIES OF MATERIALS.				
				Sand		Stone or Gravel	
Cem.	Sand	Grav. or Stone	Cem. in Sacks	Cu. Ft.	Cu. Yds.	Cu. Ft.	Cu. Yds.
1	1.5	..	15.5	23.2	.86	..	..
1	2	..	12.8	25.6	.95	..	..
1	2.5	..	11.0	27.5	1.02	..	..
1	3	..	9.6	28.8	1.07	..	..
1	2	3	7.0	14.0	.52	21.0	.78
1	2	4	6.0	12.0	.44	24.0	.89
1	2.5	4	5.6	14.0	.52	22.4	.83
1	3	5	4.6	13.8	.51	23.0	.85

Stone and gravel equal 45 per cent voids (average) 1 sack cement equals 1 cubic ft. 4 sacks equal 1 bbl.

Based on tables in "Concrete, Plain and Reinforced" by Taylor & Thompson.

North Carolina Pine Association, Inc.

NORFOLK, VA.

North Carolina Pine Is a Wood Which Economically Fills Certain Needs In the Mining Field

Products

North Carolina Pine Building Lumber for Interior Finish, Flooring, Frames, Sashes, Wainscoting, etc., in Standard and Special Grades; also for Light Structural Purposes and for Weatherboarding as hereinafter noted.

Advantages

"North Carolina Pine" is more than a trade name. It is a distinct species—the loblolly, a member of the Shortleaf family. It grows on the coastal plains of Virginia and the Carolinas and is found in no other section of the country. Natural attributes are exceptional freedom from resin, stiffness, strength, light color, beautiful and varied grain, and ease of working. For exterior use it will be found amply durable when properly protected by paint or other treatment.

North Carolina Pine is widely used for flooring and ceiling, being manufactured for this purpose on the half-inch matching basis instead of the three-quarter inch basis ordinarily used. This difference in matching basis represents a saving of about 11 per cent in the amount of wood necessary to cover any given floor or ceiling space.

This wood, as has been noted, is used also for all interior woodwork, as well as for window and door frames, doors, plasterers' laths, shingles and for exterior woodwork under the conditions noted above. It is sufficiently hard in texture to permit of an exceptionally smooth mill finish. Sandpapering will produce a surface ideal for filler.

Its Use In the Mine Field

North Carolina Pine is peculiarly adapted to the construction of company houses and other outside structures such as offices, tool and lamp houses, storehouses, etc.

Its durability (as noted above) precludes the possibility of frequent repair bills—an important item for company houses particularly, where low rentals are the rule. Moreover, this wood, being abundant, is comparatively low in first cost and can be worked with an ease which contributes still more to the economy of its use. It possesses strength amply sufficient for all suggested structural work—framework, exterior and interior. Quick delivery is almost an invariable rule when this wood is ordered because of the abundance already referred to and because, also, as we note later, it is handled by practically all dealers, who keep a large stock on hand.

The strength of North Carolina Pine is amply sufficient, also, to justify its use for still heavier structures such as tipples and pit posts. And it has durability, when protected by creosote or other preservative, second to none of the woods now commonly used for such purposes. It is peculiarly adapted to the creosote treatment and is highly recommended by those who have used it for purposes which render such treatment necessary.

Sources of Supply

North Carolina Pine is carried in stock by practically every lumber yard in the East, many of the larger concerns having planing mills and specializing on North Carolina Pine millwork. Special patterns, also, can be secured quickly and easily from these same firms.

Grading Rules

For convenience in specifying North Carolina Pine, the grades are summarized below. Complete grading rules may be obtained by writing to the association.

No. 1—Flooring, ceiling, finish, etc., is practically free from all defects on the face side.

No. 2—Flooring, ceiling, finish, etc., may contain a limited number of small, tight knots, not over ½" in diameter.

No. 3—Flooring, ceiling, finish, etc., will admit sound knots larger than are admitted in Grade No. 2, but in no case more than 1½" in diameter.

No. 4—Flooring and ceiling admits strips below the grade of No. 3, which can be laid without wasting more than 25% of the piece.

Roofers and factory flooring admit lumber below the grade of No. 3, and admit small knots and large, reasonably sound knots which do not seriously affect the strength of the piece.

Lengths—The standard lengths of flooring are 8 to 16 feet For ceiling, partition and finish, 6 to 16 feet in multiples of one foot.

Thickness—Flooring finished 13-16 inches thick. Ceiling 3-8, 7-16, 5-8, and 3-4. Finish (base and casing) 13-16. Siding and weatherboarding 3-4 or 13-16.

ASSOCIATION MEMBERSHIP

Albemarle Lumber Co.	Hertford, N. C.
Anderson Lumber Corp.	Marion, S. C.
Barnwell Lumber Co.	Barnwell, S. C.
Bogue Sound Lumber Co.	Morehead City, N. C.
Branning Mfg. Co.	Edenton, N. C.
Broaddus & Ives Lumber Co.	New Bern, N. C.
E. P. Burton Lumber Co.	Charleston, S. C.
Butters Lumber Co.	Boardman, N. C.
Camp Mfg. Co.	Franklin, Va.
Conway Lumber Co.	Conway, S. C.
Dare Lumber Co.	Elizabeth City, N. C.
Dargan-Wagoner Lumber Co.	Pamplico, S. C.
Deep River Lumber Co.	Norfolk, Va.
Dorchester Lumber Co.	Badham, S. C.
Enterprise Lumber Co.	Mt. Olive, N. C.
Eureka Lumber Co.	Washington, N. C.
Foreman-Blades Lumber Co.	Elizabeth City, N. C.
Fosburgh Lumber Co.	Norfolk, Va.
Garysburg Mfg. Co.	Burgaw, N. C.
Halsey Lumber Co.	Charleston, S. C.
Hilton Lumber Co.	Wilmington, N. C.
Jackson Brothers Co.	Salisbury, Md.
Jacksonville Lumber Co.	Jacksonville, N. C.
Johnson Lumber Co., Greenleaf	Norfolk, Va.
Johnson, K. B.	Cardenas, N. C.
Kendall Lumber Co.	Donora, S. C.
Lea Lumber Co.	Richmond, Va.
Major & Loomis Co.	Hertford, N. C.
Mallard Lumber Co.	Greeleyville, S. C.
Marion County Lumber Co.	Franklin, Va.
Meiklejohn Lumber Co.	Cheraw, S. C.
Montgomery Lumber Co.	Suffolk, Va.
Mullins Lumber Co.	Mullins, S. C.
Nansemond Lumber Co.	Suffolk, Va.
North State Lumber Co.	Charleston, S. C.
Richmond Cedar Works	Norfolk, Va.
Roanoke R. R. & Lumber Co.	Norfolk, Va.
Roper Lumber Co., John L.	Norfolk, Va.
Rowland Lumber Co.	Norfolk, Va.
Shaw Land & Timber Co.	Ivor, Va.
Simmons Lumber Co., Dennis	Williamston, N. C.
South Atlantic Lumber Co.	Greensboro, N. C.
Surry Lumber Co.	Baltimore, Md.
Trexler Lumber Co.	Allen, S. C.
Tuxbury Lumber Co., A. C.	Charleston, S. C.
Waccamaw Lumber Co.	Bolton, N. C.
Walterboro Lumber Co.	Walterboro, S. C.
Whiteville Lumber Co.	Goldsboro, N. C.
Williamson & Brown L. & L. Co.	Cerro Gordo, N. C.
Winyah Lumber Co.	Georgtown, S. C.

Carnegie Steel Company

General Office, Pittsburgh, Pa.

Steel for Service

At its various works the Carnegie Steel Company produces a complete line of steel products, whose manufacture it controls from the ore. Its materials are selected and carefully treated during manufacture so as to produce the highest excellence.

Some of its products for general use are:—

Steel: Open Hearth and Bessemer Steel, Blooms, Billets, Slabs and Sheet Bars suitable for rolling and forgings. Alloy Steels in Billet form or Finished Rolled sections for special uses, such as the manufacture of crank shafts, springs, machine parts and other specialties where great endurance and high resilience are required.

Plates: Heavy Rolled and Forged Harveyized Steel Plates for armor and vaults; Carbon and Nickel Steel Plates for bridges, ships, tanks, boilers, cars and other structural uses; all thicknesses of Carbon Steel Plates from ¼″ up to 2¼″ and widths to 132″, either rectangular or circular, universal mill sizes or sheared.

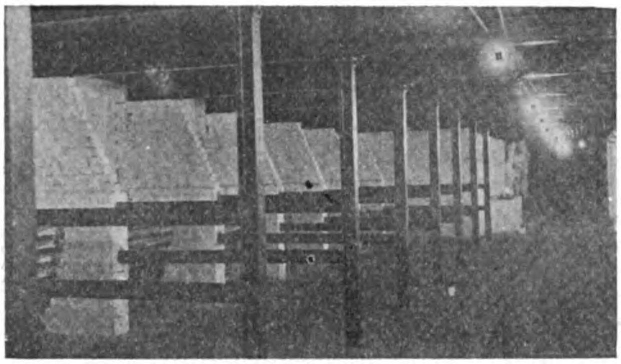
Structural Shapes: Beams, Channels, Angles, Tees, Zees and Bulb Sections for bridge, building, car and ship construction; Rolled and Fabricated Steel Sheet Piling for foundation work; Steel Derricks and Drilling Rigs for oil and gas wells.

Track Material: Standard Rails in both A.S.C.E. and A.R.A. sections, Light Rails and Splice Bars; Duquesne Rail Joints and Braddock Insulated Rail Joints; Heavy Steel Cross Ties for standard steam and electric railway track; Light Cross Ties for plantation and portable track; Lighter Steel Cross Ties for coal and metal mines.

Bar Mill Products: Merchant Bars, all kinds and sizes in Squares, Rounds, Half Rounds, Hexagons, Ovals, Half Ovals and Flats; Bands and Hoops; Cotton Ties and Skelp; Twisted Squares and Deformed Bars for concrete reinforcement; Agricultural Shapes; Tire and Vertical Spring Steel; Patented Hoop for slack barrel cooperage; Vehicle, Harness and Automobile Sections; Window Sections.

Forged Products: Heavy Crank Shafts, Driving Axles, Crank Pins and Arch Bars; Standard Steam and Electric Railway Axles standard forged or heat treated to specification; Mine Car and Industrial Axles.

Some of its products with particular reference to uses in connection with mines are:—



Underground Stable, Federal Coal & Coke Co., Grant Town, W. Va.

Steel Mine Timbers: Conservative figures indicate that a mine owner can pay at least three times as much for steel mine timbers as for wood and get equivalent value for his money.

The difference, however, in most cases is very much less. In fact, in some instances, the first cost of an installation of steel is no higher than one of wood of equivalent strength.

Steel Cross Ties: Steel ties will last three or four times as long as wood ties.

The difference in depth between steel ties and wood ties results in the saving of head room which is an important consideration, especially in thin veins of coal.

Carnegie Rolled Steel Wheels: The severe shocks to which mine cars are subject demand something much more substantial than the old style cast iron wheel.

The wheels made by this company are rolled from a solid disk and are safe for the most severe usage.

Carnegie Rolled Steel Gear Blanks: These blanks are also rolled from solid steel disks. A prominent gear cutter places his case hardened forged steel gears cut from Carnegie blanks at 500 as against 100 for his standard cast steel gears. The best are in the end the cheapest.

Carnegie Axles: More than fifty years ago these were considered the best obtainable. They are still the standard of excellence.

The mark of quality CARNEGIE **It protects the user**

LEHIGH PORTLAND CEMENT CO.

Main Office

ALLENTOWN, PA.

Main Western Office
Chicago, Ill.

Pacific Coast Office
Spokane, Wn.

Branch Offices

New York Boston Philadelphia Buffalo Jacksonville Pittsburg
New Castle, Pa. Mason City, Ia. Minneapolis Kansas City, Mo.
Omaha, Neb. Richmond, Va.

Mills at

Ormrod, Fogelsville, West Coplay and New Castle, Pa.; Mitchell, Ind.; Mason City, Iowa;
Metaline Falls, Wn. Iola, Kan. Oglesby, Ill. Fordwick, Va.

Products and Services

Lehigh Cement—guaranteed to conform in every respect to present Standard Specifications for Portland Cement as adopted by the American Society for Testing Materials when tested by methods of testing recommended by the American Society of Civil Engineers.

For those customers desiring to test their own cement, we will reserve and seal bins for any amount desired.

Marketing and Shipping Facilities

Lehigh Mills are located at strategic points from the Atlantic to the Pacific. In all the principal marketing centers, branch offices have been established for the convenience of our customers.

Lehigh Cement is marketed in cloth or paper bags for domestic trade, and in barrels for export trade. The bags contain 94 pounds net (four bags to the barrel), and the export barrel contains 376 pounds net. These barrels are made in our own cooperage plant, and are tongued and grooved to withstand the rough handling necessary in export trade.

For Mine Officials' Convenience

To any mine official writing us on the stationery of his firm and mentioning the Coal Field Directory, we will send our celluloid computing scale, giving the amounts of cement, sand and stone required per cubic yard of rammed concrete of different proportions.

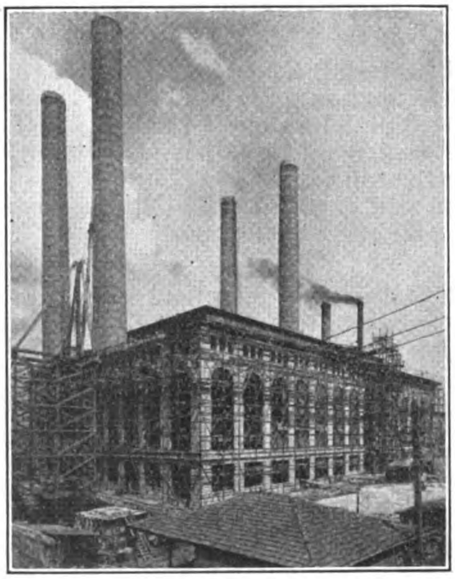
Use

In practically every type of modern construction, the use of cement is required. In great engineering works, concrete is the essential material.

In mine work concrete has earned a deservedly prominent position for the main buildings of the mine, the homes of mine employes, and also for mine timbering and shaft linings.

The careful selection of the ingredients for concrete is a big factor in the success of the finished work. The selection of Lehigh Cement is a warranty for the most important material used in concrete.

Perhaps the best guarantee on future promise is past performance. The great New York Connecting Railroad; the Municipal Building, New York; the Girard Point Elevators, the League Island Dry Docks, Philadelphia; the Boston Braves' Ball Park; the Chicago and Northwestern Railway Terminal; the Quay and Sea Walls, Charlestown; the Galveston Causeway—these are a few of the structures where Lehigh is on the job.



A typical example of the adaptability of concrete to varying structural requirements. Chimneys and building are of concrete.

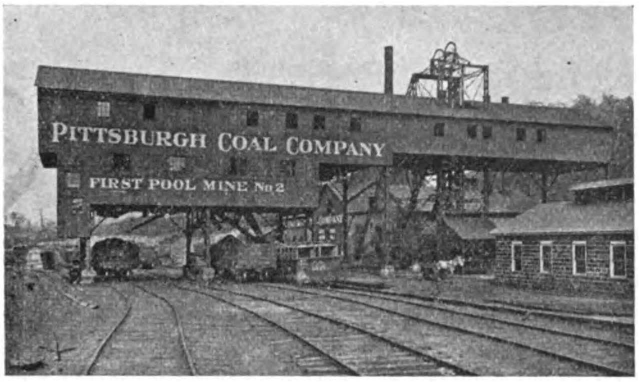
NATIONAL FIRE PROOFING CO.

Fulton Building, PITTSBURGH

Collieries, Machine Shops, Breakers, Brattice Work, Fan Houses, Etc.

Collieries, Machine Shops, Breakers, Etc.

Of all the industrial buildings in the nation, there are none that should be made so dependable and indestructible as the collieries, machine shops and breakers incidental to the coal mining industry.



Note the Natco Building Tile Washhouse, typical of the many buildings erected for the largest coal companies.

The amount of time lost in production, through breakdowns, fires, replacements, etc., involves an enormous maintenance expense from which the operator never realizes any returns.

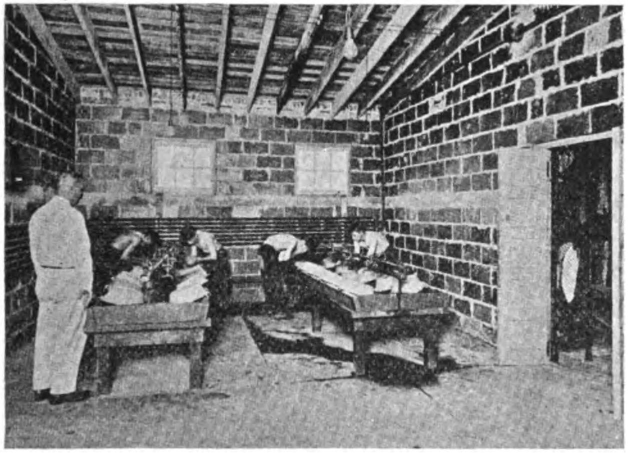
This continual expense is eliminated by replacing your old buildings or building your new ones with **Natco Hollow Tile.**

Its use in this connection provides a building that withstands the jolts and jars of heavy machinery and traffic in and about a coal mine—no wood work repairs—no painting and absolutely fireprooof.

The initial cost of a **Natco** structure is a trifle more than frame, but, in the course of a few years, the elimination of repairs, painting, break-downs, etc., will more than offset this difference, and remember, a **Natco** building stands for all time.

Wash Houses and Lavatories.

Nothing quickens the spirit of a miner more, after a long hard day in the pit, than a good wash before going home.



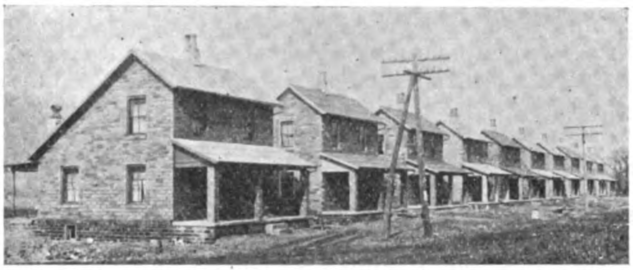
Sanitary Wash House of Natco Hollow Tile.

Grasp this opportunity to create a feeling of satisfaction in your army of workmen (whose contentment, after all, is your success) by providing for them an inviting and sanitary wash house.

A building of this kind must be warm in winter and cool in summer—dry and sanitary—neat and attractive, yet economical. It should be absolutely fireproof and above all—permanent. Many mining companies have built such houses with adjoining toilets at a minor cost, having used the ideal building material—**Natco Hollow Tile**, glazed or unglazed, smooth, texed or deeply scored for plastering. With each type a smooth, sanitary and attractive finished wall surface is obtained.

Community Houses, Townhalls and School Buildings.

The type of dwellings used in building a mining village invariably stamps the character of those who build and own them.



Repair-proof Miners' Houses.

A slipshod, unsafe mass of tumble-down frame shacks usually discloses a careless and irresponsible management, continually adjusting strike disputes or maintaining a plant that is constantly shut down for repairs.

On the other hand, a village of well built, neat and durable houses, surrounding a roomy school house, a well-kept townhall and church, is evidence enough that the conservative operators are prospering by the united efforts of a contented and efficient force of workmen.

A Fire-safe School House.

Natco Hollow Tile is used extensively in the construction of miners' houses. Its damp-proof, vermin-proof and fire-proof qualities make it the ideal building material—a home that is warm in Winter and cool in Summer. Its superior strength and general composition make it a material that lasts for all time—no woodwork repairs and no painting. Its cost is from 5% to 10% over that of all frame construction, but wiping out the maintenance expense, the saving in coal for heat and the reduction in fire insurance will soon offset this difference.

A Stately Church and Always Comfortable.

Natco Tex-Tile is a hollow tile, made in smaller units for use in dwellings, as well as churches, schools, etc. Its outer surface provides a wall of an attractive, glazed or unglazed, varicolored, rough texture face. The inner surface is either smooth, texed or deeply scored for plastering.

Full information about this very desirable building material is available to those requesting it. Our service department is at your command. When confronted with fireproofing problems, permit us the opportunity of assisting you.

TRUSSED CONCRETE STEEL CO.

Main Office and Factory
YOUNGSTOWN, OHIO, U. S. A.
Manufacturers of

Kahn Building Products

Products

Reinforcing Bars, Kahn Trussed Bars, Rib Bars, Rib Metal, Column Hooping, Hy-Rib, Metal Lath, Pressed Steel Joists, United Steel Sash, Kahn Mesh, Wire Mesh, Truscon Steel Buildings.

Hy-Rib

Hy-Rib is a steel sheathing stiffened by deep ribs, manufactured from a single plate of steel. Hy-Rib is a combined form, reinforcement, lath and channels for concrete, stucco, and plaster. It can be used in all buildings, large or small, in roofs, floors, partitions, and for special construction, as conduits, culverts, etc.

Properties of Hy-Rib

Type of **HY-RIB**	Height of Ribs	Spacing of Ribs	Width of Sheets	Gauge Nos. U. S. Standard
1½ **Hy-Rib**	1½"	7"	14"	22, 24, 26
15/16 **Hy-Rib**	15/16"	4"	24"	22, 24, 26, 28
13/16 **Hy-Rib**	13/16"	8"	16"	24, 26, 28
⅜ **Hy-Rib**	⅜"	4"	20"	24, 26, 28

Hy-Rib lowers the cost of buildings because it eliminates forms, and saves materials, labor and time. Hy-Rib provides permanent, fireproof construction which ultimately proves the most economical.

Floors

In concrete floors Hy-Rib eliminates forms and rigidly reinforces the concrete. It simplifies construction and permits the construction of flat or arched floors with any type of beam.

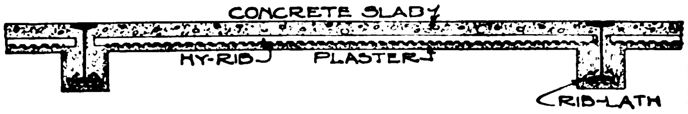


Fig. 1. Hy-Rib Floor—Type B.

For flat, non-arched floors Hy-Rib is laid over the supports and concrete poured over top. Only enough concrete flows through the mesh to secure a permanent clinch on the steel. Plaster is applied directly to the under surface. This is not absolutely necessary, but is desirable in order to protect any exposed parts of the Hy-Rib. Arched floors require curved Hy-Rib, and with I-beams, Hy-Rib is used in the manner shown.

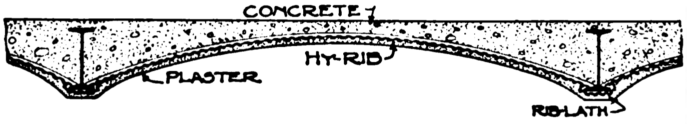


Fig. 2. Hy-Rib Floor—Type E.

Conduits

Hy-Rib offers the best means of constructing permanent conduits, culverts, and sluices. Continuous steel-reinforced concrete conduits can be installed almost as cheaply as tile and have all the defects of tile eliminated. The 15/16" Hy-Rib is bent to perfect curve at our shops. The sheets are shipped nested, and need only to be set up in line. Absolute continuity of reinforcement is secured by the positive interlocking of the sheets at the ends and sides. Side forms only are required, as shown in the figure, and either side of the Hy-Rib may be plastered first. A few rods, extending the length of the conduit, should be provided as additional reinforcement.

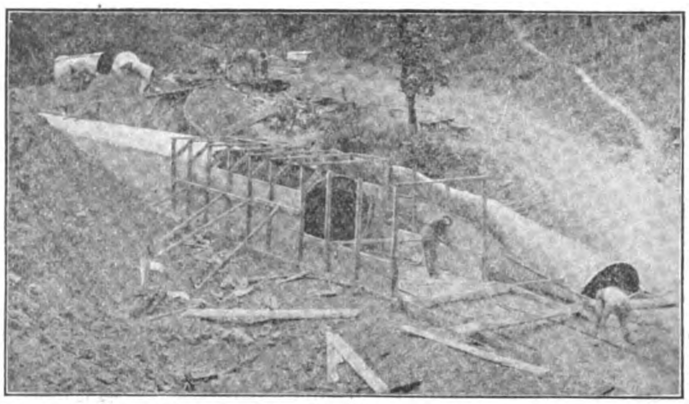


Fig. 3.
Hy-Rib Concrete Culvert, Charleroi Mine, Carnegie Coal Co.

Walls

Hy-Rib is ideal for sidings and curtain walls of industrial buildings, tipples, power plants, breakers, motor barns, machine shops, etc. Such a wall is fire-proof, costs half as much as brick, and needs no painting or maintenance of any kind.

For the construction of fan houses, Hy-Rib is especially well adapted. Once in place it forms an enduring, airtight casing, requiring no upkeep and permitting absolutely no loss of air by leakage.

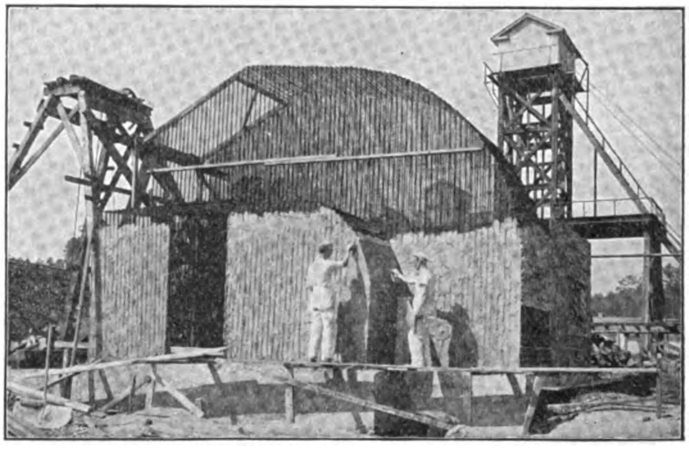


Fig. 4.

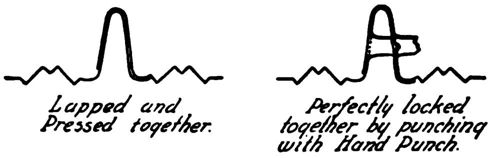

Lapped and Pressed together.
Perfectly locked together by punching with Hand Punch.

Fig. 5.

When used as walls and partitions the sheets of Hy-Rib are interlocked and fastened together as shown in the drawing. A special tool is made for doing this work rapidly, but on small jobs the punching may be done by hand.

Truscon Steel Buildings

Truscon Steel Buildings are built up of high grade, heavy gauge, openhearth steel panels, cut and formed, ready for erection. These units can be assembled by any one, and without special tools. No holes need be punched, no rivets driven, no bolts or wire used.

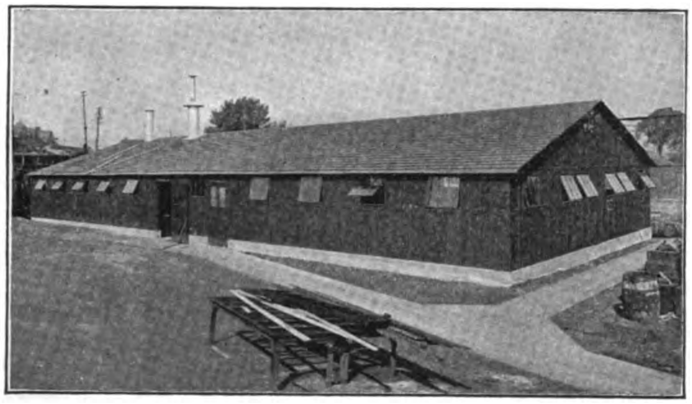


Fig. 6.

They are durable, economical and easily erected.

Uses

Truscon Steel Buildings can be used anywhere a single story building is needed. They can be and are used for time offices, scale offices, fireproof sand houses and oil houses, tool houses, shops, sanitary workingmen's houses and bunk houses.

Advantages

Fire-resistance. They are altogether fireproof; there is nothing in a Truscon Steel building to burn. Steel from top to bottom, it assures the fireproofness and protection of the building and its contents.

Permanence. A coat of paint every two or three years is all that is necessary as maintenance. The building is solid and rigid; it is not composed of flimsy, light sheets, riveted or wired together.

Speed of Erection. All panels are connected by a device consisting of a slotted key into which a locking wedge is driven. (See Fig. 9.) Driving home the locking wedge makes a firm, solid, and rigid connection. A few men can easily handle any section, and do all the work in connection with the entire building. Full instructions for erection accompany all buildings with complete diagrams illustrating each step.

Flexibility. Should it be necessary to change the size of the building in the course of time, it can be easily and quickly done. The various units are of the same size and interchangeable. They can be rearranged as desired.

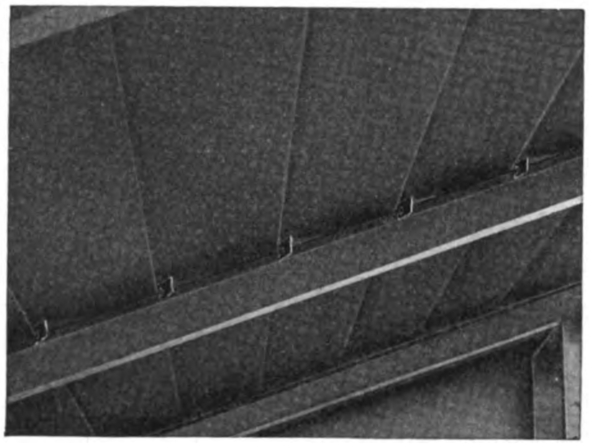


Fig. 8.

Weathertightness. The heavy steel mullions between the panels form perfect weather strips; the roof plates have an airtight interlocking connection. Around the gables, eaves, windows, etc., connections are weathertight, shutting out draughts, rains and storms.

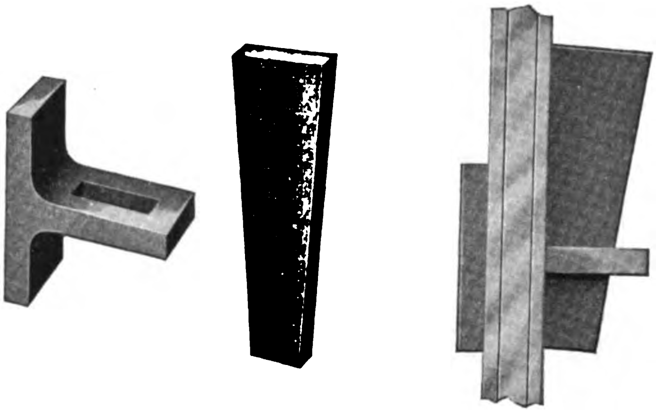


Fig. 9.

Tee bolt and wedge for the standard connection.

Section showing completed standard side wall connection.

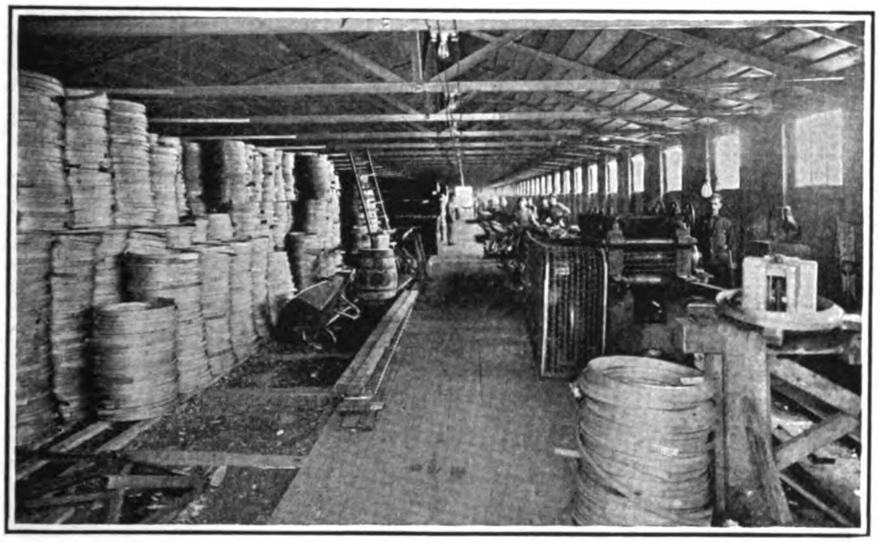


Fig. 7.

Equipment

Doors are furnished with heavy butt hinges, Yale locks, and suitable handles. For double doors a top and bottom bolt are supplied. Steel sash, welded into the standard panel, provides light and ventilation. Any or all of the panels may be equipped with sash. The steel doors are all equipped for glass.

Erection

A specially devised T-Bolt and wedge connection makes erection a simple matter. Unskilled labor and a few ordinary tools is all that is required. Complete erection drawings, showing method of erection, field number of units, etc., are provided with each building.

Foundation

A sill only is required for foundation. This may be a timber, planks spiked together, or it may be concrete or brick.

Reference

A list of users of our products in your district will be sent on receipt of request.

AMERICAN SHEET & TIN PLATE CO.

General Offices:
FRICK BUILDING, PITTSBURGH, PA.

District Sales Offices:

CHICAGO
CINCINNATI
DENVER
DETROIT
NEW ORLEANS
NEW YORK
PHILADELPHIA
PITTSBURGH
ST. LOUIS

Export Representatives: United States Steel Products Company, New York City
Pacific Coast Representatives: United States Steel Products Company, San Francisco, Los Angeles, Portland, Seattle

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Products

Apollo Best Bloom and Apollo-Keystone Copper Steel Galvanized Sheets, Black Sheets of every description, Corrugated Sheets, Formed Roofing and Siding Products, Electrical Sheets, Planished Iron Sheets, Polished Steel Sheets, Special Sheets for Special Purposes, Bright Tin Plates, Keystone Copper Steel Roofing Tin Plates, etc.

Keystone Copper Steel

KEYSTONE
COPPER STEEL

Is a scientific and correct combination of Copper and high grade Steel, thus forming a new metal or Copper Steel alloy. Actual time and weather tests have proved the superiority of this material in resisting rust and corrosion. Keystone Copper Steel is supplied in Black and Galvanized Sheets, Roofing Tin Plates, and Corrugated and Formed Products. Look for the added Keystone when Copper Steel is used.

Flat Standard Galvanized Sheets.

AMERICAN SHEET & TIN PLATE CO.
APOLLO
BEST BLOOM
TRADE MARK REGISTERED
PITTSBURGH
KEYSTONE
COPPER STEEL

Stencil on Flat Keystone Copper Steel Galvanized Sheets.

Apollo Best Bloom Galvanized Sheets

Since 1884 these Sheets have been prime favorites and are recognized for their fine working quality, uniformity, and good galvanizing.

Apollo-Keystone Copper Steel Galvanized Sheets

These Sheets possess an added degree of durability through the use of Keystone Copper Steel for the base, thus assuring greatest service and rust-resistance. Unequaled for Culverts, Tanks, Flumes, Roofing, and is specially adapted for work in the mining and engineering fields.

Black Sheets

We manufacture Black Sheets of every description and for every known purpose. All our standard steel sheets can be supplied from Keystone Copper Steel on specification. When this Copper Steel Alloy is used the Keystone is added to brand.

Keystone Copper Steel Roofing Tin

Highest quality plates manufactured and specially adapted to roofing residences, mercantile and public buildings. Grades up to 40 pounds coating—durable, fireproof, satisfactory—stamped "Keystone Copper Steel" in addition to brand and weight of coating. These plates insure service and satisfaction.

Corrugated and Formed Roofing and Siding Products

Supplied from Apollo or Apollo-Keystone Copper Steel Galvanized Sheets in all standard corrugations, also curved corrugated sheets. We manufacture V-crimped Roofing, Pressed Standing Seam Roofing, Pressed Brick and Stone Siding, Ridge Roll, V-capping, etc. Unexcelled for service and fire protection.

Corrugated Standard Galvanized Sheets.

AMERICAN SHEET & TIN PLATE CO.
APOLLO
ROOFING
TRADE MARK REGISTERED
PITTSBURGH
KEYSTONE
COPPER STEEL

Stencil on Corrugated Keystone Copper Steel Galvanized Sheets.

Booklets and Literature

We should be pleased to send upon application booklets giving full information on products of our manufacture, and also describing service tests of Keystone Copper Steel. These booklets are of particular value and interest to mining engineers, contractors, and coal operators. Address nearest sales office.

THE STARK ROLLING MILL CO.

CANTON, OHIO

TONCAN METAL

Corrosion-Resisting Sheets, Roofing, Siding, Etc.

Products

Toncan Metal Black and Galvanized Corrosion-resisting Sheets for Roofing, Siding, Eaves Trough, Conductor Pipe, Ventilators, Skylights, Tanks, Window Frames and all other purposes where durable sheet metal is needed.

Description

Toncan Metal is a corrosion-resisting metal sheet made from iron ore, and procurable in the galvanized, painted or black form. It is capable of resisting the action of moisture, fumes and other severe conditions in and around coal mines better than any other sheet metal made from iron ore. In fact, it has been known to outlast steel sheets 400% under extremely severe conditions.

Briefly, its durability is due to its purity, homogeneity and scientific processes of manufacture.

It is very moderate in cost.

Further Information and Evidence

Write for "Corrosion—The Cause—The Effect—The Remedy" for complete information regarding Toncan Metal. Also write for the "Evidence Book," showing prominent installations.

Source of Supply

Any sheet metal contractor, roofer or tinner can furnish Toncan Metal Products. Prominent Jobbers everywhere carry complete stocks.

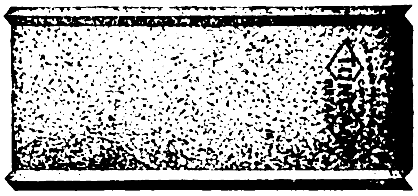
Hocking Mine No. 2, Vandalia Coal Co.
Near Farmersburg, Ind.
Toncan Metal Roofing and Siding.

Corrugated Roofing and Siding

Covering width—24″. Lengths—5 to 12′. Gauges 10 to 28 inclusive.

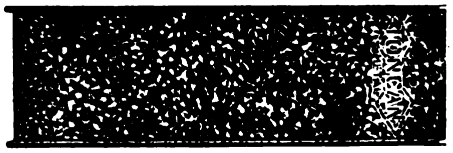
V-Crimp Roofing

Covering width—24″. Gauges—16 to 28 inclusive. Lengths—5 to 12′.



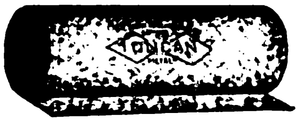
Standing Seam Roofing

Covering width — 24″. Gauges — 20 to 28 inclusive. Lengths 5 to 12′.



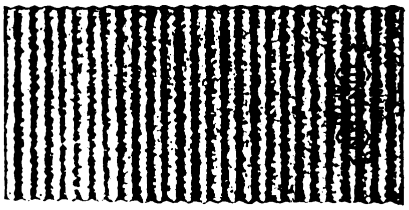
Roll Roofing

Covering width 24″. Each roll contains 100 sq. ft.

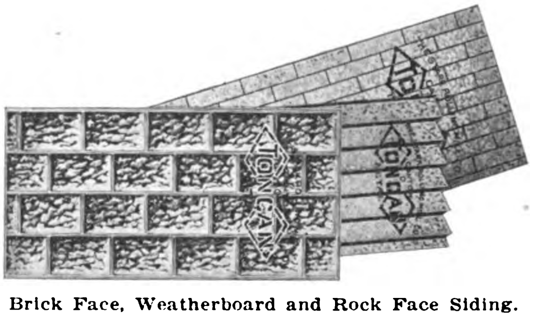


Cross Corrugated Siding

For tall buildings. Size—32″ long by 26″ wide. Gauges—16 and lighter. Corrugations — 1¼″, 2″ and 2½″.



Write for information regarding Toncan Metal Conductor Pipe, Eaves Trough, Flashing, Ridge Roll, etc.



Brick Face, Weatherboard and Rock Face Siding.

THE BARRETT COMPANY

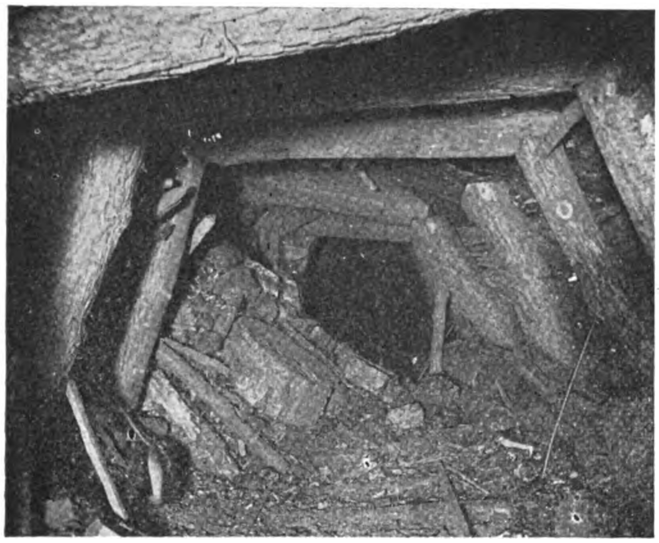
NEW YORK CHICAGO PHILADELPHIA BOSTON ST. LOUIS
CLEVELAND CINCINNATI PITTSBURGH DETROIT BIRMINGHAM
KANSAS CITY MINNEAPOLIS NASHVILLE SALT LAKE CITY SEATTLE
PEORIA

THE PATERSON MANUFACTURING COMPANY, Limited: MONTREAL TORONTO WINNIPEG
VANCOUVER ST. JOHN, N. B. HALIFAX, N. S. SYDNEY, N. S.

Barrett Specification Roofs

Barrett's
TRADE B MARK
Carbosota
Grade-One Liquid
Creosote Oil

Coal-Tar Products



Mine-Timbers Not Creosoted. Note Decay.
(Courtesy U. S. Forest Service.)

Coal mines in general have a high humidity, which causes conditions favorable to the development of wood-destroying organisms and insects. Timbers used for props, collars, caps, legs, etc., shaft-timbers and ties decay very rapidly.

Approximately 250,000,000 board feet of sawed timbers and 150,000,000 cubic feet of round timbers are used annually in the coal mines of the United States. The percentage of waste due to decay is greater than in any other industry.

All wood used in mines in permanent locations **should be creosoted.**

The Open-Tank System is the most convenient, economical and efficient. Where working conditions require only a few years' (3 to 5) increase in the life of timbers the Brush Method of treatment is to be recommended. It is very effective for this purpose and inexpensive.

In some exceptional cases where mechanical conditions necessitate a heavy impregnation of the wood the pressure process of treatment is advisable.

Preservative treatment of mine-timbers with Barrett's Carbosota Grade-One Liquid Creosote Oil nearly doubles their natural life.

COMPARATIVE CONDITION OF TREATED AND UNTREATED LOBLOLLY PINE GANGWAY SETS.
Placed in mines by the U. S. Forest Service.

	After 2 yrs. Service			After 3 yrs. Service.		After 4 yrs. Service.	
	Sound	Partly Decayed	Replaced	Sound	Replaced	Sound	Replaced
Untreated ...	5%	10%	85%	none	100%	....	....
Treated *.....	85%	....	15%	82%	18%	75%	25%

*Treated with Coal-tar Creosote Oil by the Open-Tank Process (4 to 6 pounds per cu. ft.).
(Bulletin 107 U. S. Forest Service.)

Timbers and lumber used in surface structures, although not exposed to conditions as severe as those found below ground, are also subject to decay and should likewise be given preservative treatment. For such work the Brush Treatment will very often be found most convenient.

The Open-Tank System and Brush Method require an especially refined grade of Creosote Oil, and for this purpose Barrett's Carbosota has been particularly produced. It combines to a maximum degree all the necessary elements.

BARRETT'S CARBOSOTA is:

1—**Toxic**—Poisonous to wood-destroying fungi and bacteria.
2—**Penetrating—Readily absorbed by wood.**
3—**Uniform.**
4—**Permanent**—Insoluble and non-volatile.
5—**Convenient to handle and apply.**
6—**Economical.**

Creosoted Mine Timbers.
(Courtesy U. S. Forest Service.)

THE BILLINGS-CHAPIN CO.

438 Pearl Street,
NEW YORK
Telephone, Worth 1354

1163 40th Street,
CLEVELAND, OHIO
Telephone, Prospect 3252

146 High Street,
BOSTON, MASS.
Telephone, Main 4137

THE MARK OF QUALITY
BILCHACO
IN PAINTS AND VARNISHES

House Paints, Cement Coatings, Varnishes, Stains and Enamels

Products

We manufacture house paints, shingle stains, roof paint, Flexo-Flint Finish, Rubeffect (a flat finish varnish), Flo-rite (the perfect white enamel), Cement Coatings, Driwal (waterproofing), Bilchaco Cement Floor Coating, Rostnicht (the anti-rust and insulator for structural steel), Artone (for wall decoration of plaster, wood or metal ceilings) and allied products.

House Paint

Permanency and the maximum spreading capacity are what make for the greatest economy in paint. Nearly forty years experience in the manufacture of paints of the highest grade, qualify us to meet the needs of all classes of buyers. Most paint looks well when first applied, but time shows the difference between the cheap and the quality kind.

When you engage a man to do an important work do you engage one who is willing to write you out a guarantee as to his honesty and reliability; or do you engage one who has this reputation among those who have had the most experience with him and who are known to you as men of standing in the community?

Next to the pride we take in our products, we take pride in the reputation of those who have used our products and speak well of them.

Rostnicht

"Rostnicht" is a protective coating for steel, iron and other metal against rust, and should be specified for all steel coal tipples, coal cars and all steel work exposed to coal fumes and sulphuric gases. This coating is made with a view of checking electrolytic or galvanic action which investigations* by responsible bodies have proven is the chief cause of corrosion. Rostnicht contains ingredients best calculated to act as insulators and contains no asphaltum nor tar. It will successfully resist sulphuric acid fumes, brine and lubricating oil. Rostnicht is also especially suitable for metal roofs and other metal surfaces exposed to severe weather conditions, as it is an anti-rust coating of greatest durability. Rostnicht is made in various colors so that the field coat can be distinguished from the shop coat.

Creosphalt

An inexpensive yet durable paint for wood coal tipples, boiler fronts, smoke stacks, etc.

"Driwal" Decoration for Concrete and Brick

A waterproofing and decorating coating for cement, stucco, brick and similar surfaces. "Driwal" prevents dampness, efflorescence and staining. Made in fourteen colors, including greens, browns, reds, yellows and stone colors; white and black; also, transparent. "Driwal" will not blister or peel if properly applied. It penetrates, stains and preserves the texture of the surface. Has no disagreeable odor.

Artone Interior Painting—Walls, Cellings, Etc.

"Artone" produces a beautiful velvetlike flat finish. It is designed for use over "Artone First Coater" on smooth or rough plaster, cement, brick, wall board, and on metal or wood. It is sanitary, durable, and can be cleaned with soap and water or disinfectants.

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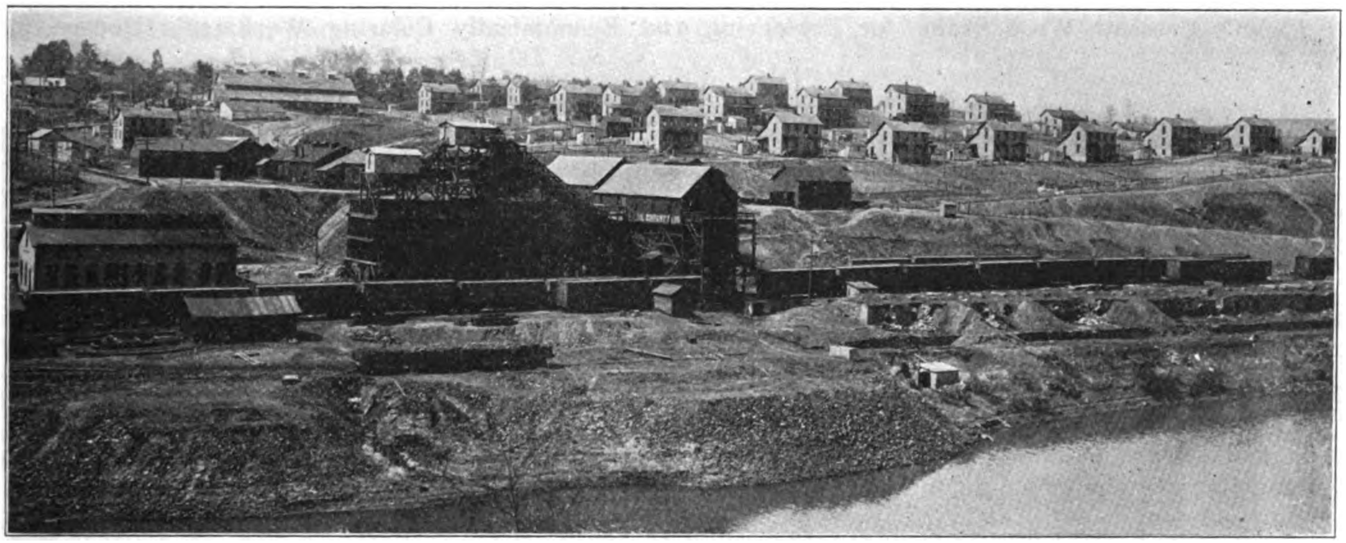
*See Report of American Society for Testing Materials.



New England Mine of Consolidation Coal Co. This is one of the mines of which the buildings are coated with Bilchaco paint.

SAMUEL CABOT, INC.

Manufacturing Chemists

1133 Broadway
NEW YORK, N. Y.

141 Milk Street, BOSTON, MASS.

24 W. Kinzie Street
CHICAGO, ILL.

Conservo Wood Preservative

A Penetrating, Permanent Preservative for Mine Timbers and all other Lumber

Description

Conservo is a compound of high boiling coal-tar distillate, non-volatile, insoluble, non-viscous and antiseptic. Its tone on wood is rich butternut brown.

It is a scientific product made to cover the three cardinal principles of wood preservation, viz:

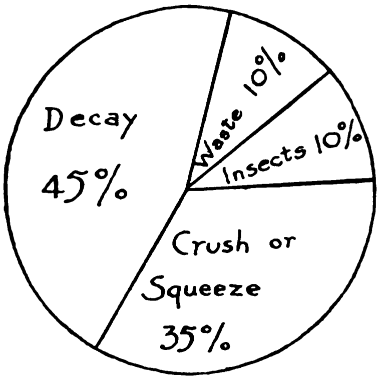
1. Penetrating Power.—No preservative can preserve unless it penetrates. Most heavy preservatives fail because they are so heavy and viscous that they cannot get into the wood, but remain on the surface and are washed off by rains or other moisture. Conservo is so limpid that its penetrating power is far greater.

2. Permanence.—Conservo is so non-volatile that it will not evaporate at any temperature to which it can be subjected after application. It goes in and stays in.

3. Sterilizing Power.—Decay is caused by bacteria, and conservo has always carried the proper percentage of Tar Acids—7 to 10%—to sterilize the wood and poison the bacteria. The Tar Acids also increase the penetration and combine with the sappy parts of the wood and form asphaltic bases that are permanent.

Cost

Price of Conservo, 50 cents per gallon in barrels, f. o. b. Boston. The cost of treating depends upon the method selected, the character and condition of the wood, and the economy of handling, which includes wages, waste, etc.



The U. S. Government investigation shows that:

45% of Mine Timber is wasted by Decay.

10% more by Insects.

The Cost of Replacing is vastly more than the cost of the timber.

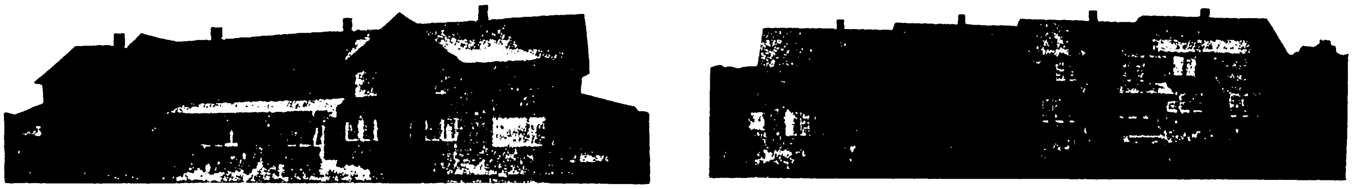
Covering Capacity

Brush Coating—One gal. covers about 100 sq. ft. of rough sawed lumber, two coats; one gal. covers about 200 sq. ft. of rough hewn lumber, two coats; one gal. covers about 250 sq. ft. of dressed lumber, two coats.

Dipping—About the same as brush coating, if the Conservo is drained back into the dipping tank to prevent waste.

Soaking—The covering capacity varies so greatly for both methods of soaking, owing to differences in wood, heating, length of immersion, etc., that it is impossible to give exact figures; but simple soaking for a short time will take about twice as much as dipping; the vacuum process, from four to twelve cubic feet per gallon.

Cabot's Creosote Wood Stains for Preserving and Economically Coloring Workmen's Houses.



Buildings at Southern Aluminum Co.'s Workmen's Village Stained with Cabot's Creosote Stains.

Low Cost

Cabot's Stains cost less than half as much as paint, and the cost of applying is also less than half because they can be put on twice as fast, with wide, flat brushes or a spraying machine. Any intelligent laborer can apply them.

Handsome and Lasting Colors

The colors are rich and handsome and they make the houses picturesque and attractive, besides preserving the wood against decay and insects. They wear as well as the best paint. Thousands of gallons are being used by coal mining companies in their housing operations.

Samples of Colors, Prices and Full Information will be Sent on Request.

CHEESMAN AND ELLIOT

Established 1876

Main Sales Office
100 William St. NEW YORK

Plants at
Williamsport, Pa. Brooklyn, N. Y.

Western Penna. Sales Representative
Whiteman & Co., Punxsutawney, Pa.

Products

Paints and Enamels especially manufactured to meet specific requirements.

We are thoroughly acquainted with mining conditions and many of the leading mining companies have found that Cheesman & Elliot's Paints are entirely satisfactory.

Descriptions

For more than forty years we have been supplying a large consuming trade direct.

Our belief that the best paint results are only to be obtained by a careful consideration of the conditions to be met and the special manufacture of a paint to meet those conditions has proven correct by the ever increasing volume of our business.

The following recommendations are made always with this proviso: if the paint has any extraordinarily severe conditions to withstand, we cannot properly advise you without full and complete information.

The right paint does not necessarily mean the most expensive paint. We are not financially interested in any particular type of pigment or vehicle and all of our recommendations are based on actual results we have secured.

Wooden Building Paints

Houses and Other Wooden Structures

Our N. P. W. Prepared Paints are made of highest grade materials in every respect, and manufactured especially for wood. We issue a special color card covering these paints, but match any color desired. These paints are used on residences as well as industrial plants, and other wooden structures.

Protective Paints for Metal

Tipples, Structural Steel, Sheet Metal, Etc.

For this class of work we recommend the use of a priming coat of our No. 31 Williamsport Red Oxide of Iron Paint followed by a coat of our No. 16 Carbon Black Paint. The coating formed by these paints is very elastic and gives the greatest possible protection to the metal, with the longest durability. Of course, the metal should be clean before the application of paint, and old paint removed except where it is in good condition and firmly attached to the metal. Either of the above paints alone will give good results, but when used in combination the very best results may be expected.

Stacks, Flues, Boiler Fronts, Etc.

Our No. 750 Smoke Stack Black will stand a higher temperature than any other paint, and produce a glossy jet black protective coating of fine appearance. We also furnish graphite stack paint, but recommend No. 750 as even superior (and less expensive) for the large majority of cases.

Brick and Concrete Paints

Paints for waterproofing and beautifying brick and concrete structures are manufactured by us with special vehicles suitable for this class of work, and furnished to match any color.

White Interior Paints for Illumination

The use of white paints for coating interior walls, etc., is now generally recognized as an economy by manufacturers, and progressive concerns are realizing the advantage and ultimate economy of using durable, washable oil paints rather than white wash or water paints, which are not permanent and cannot be kept clean and bright.

We recommend highly our Newlite Flat, Newlite Semi Gloss, and Newlite Gloss Whites for this class of work.

These paints are extremely durable, permanent in whiteness, and can be used on brick, concrete, plaster, wood or metal.

Concrete Floor Paints

These paints are made in all colors, and are effective in their power to penetrate the concrete and prevent the formation of concrete dust. We incorporate a high grade elastic floor varnish in our Concrete Floor Paints which produces a fine finish and withstands wear remarkably well.

Steel Mine Cars and Piping

For this work we recommend our No. 500 Black Metal Protector.

Wooden Tipples

Use our Red or Brown Oxide of Iron Paints. They insure the greatest durability at a low cost.

Galvanized Iron

Galvanized Iron should be given a priming coat of our No. 625 Galvanized Iron Primer. This paint is especially prepared for this class of work, and when used under conditions suitable for the application of any good paint, gives a coating that is extremely durable and will not peel off. After No. 625 has been applied any good paint can be used for succeeding coats.

Other Paints

Besides the few paints mentioned on this page, we are prepared to furnish at once, in any quantity from one gallon up, any kind of approved paint for any purpose. While we believe in certain pigments and vehicles as being best suited for certain classes of work, our line comprises practically the entire field of protective and decorative paints. We are not prejudiced in favor of any class of pigment or vehicle, except for the results that may be expected from them.

If you will let us know your wants, we will do our best to fill them to your satisfaction.

Customers

The following list of customers have chosen Cheesman & Elliot's paints:

In most cases they have made their choice after rigorous and searching tests. The fact that we solved their paint problems are a guarantee of our ability to solve yours. We should welcome an opportunity of supplying any additional information.

We mention among our leading clients—Rochester & Pittsburgh Coal & Iron Co., Reading Coal & Iron Co., Lehigh Valley Coal, Davis Coal & Coke Co., American Bridge Co., Bethlehem Steel Co., New York & Pennsylvania Co., General Chemical Co., International Nickel Co., Anaconda Copper Co., West Va. Pulp & Paper Co., Eastman Kodak Co., General Electric Co., Atlas Portland Cement Co., Lehigh Coal & Navigation Co., Colonial Collieries, American Car & Foundry Co., Tennessee Copper Co., Niagara Falls Power Co., Endicott-Johnson Co., Pennsylvania Railroad, Buffalo, Rochester & Pittsburgh Railroad, McClintic Marshall Co., Harleigh Brookwood Coal Co., Jefferson & Clearfield Coal & Iron Co., Phoenix Iron Co., Riter Conley Mfg. Co., American Smelting & Refining Co., Belmont Iron Works, Consolidated Gas Co. of N. Y., Garrett County Coal & Mining Co., etc.

DETROIT GRAPHITE COMPANY

DETROIT MICH.

Branch Offices

New York, Chicago, Boston, Philadelphia, Cincinnati, Cleveland, Buffalo, St. Louis, Kansas City, Birmingham, Greenville, S. C., Springfield, Mass., San Francisco.

Paint and Color Makers

Products

PAINTS, ENAMELS and COATINGS, including SUPERIOR GRAPHITE PAINT; DEGRACO HOUSE PAINT, interior and exterior; STA-WHITE, a white finish for industrial interiors; DEGRACO-TONE, flat finish for interiors; DEGRACO-LITE, for wood or metal trim; DEGRACO PAINT, a protective coating; "ANTI - AQUA" DAMP-PROOF COATING; DEGRACO WOOD PRESERVATIVE; DEGRACO CONCRETE WALL and FLOOR PAINTS; NO. 22 B. GRAPHITE, for removing scale in boilers, etc.

To properly protect the equipment and surfaces around mines, it is necessary that special paints be furnished to meet the unusual conditions encountered. With this in view, we have carefully studied coal mining conditions, and the paints offered are believed to be the most durable and therefore the most economical that can be purchased.

Structural Steel, Tipples and Breakers

For painting these surfaces "Superior Graphite Paint" No. 30 is recommended. This paint is unaffected by exposure to any atmospheric conditions or gases and dripping of sulphur water from coal. It covers an unusually large surface per gallon and has great durability.

Wooden Tipples

For wooden tipples we recommend a very durable red in Nos. 210 and 313. Other shades are also offered. These paints are made specially for wooden tipples. They cover well, preserve the wood, and, because of their low price and high covering capacity, are largely used for this class of equipment.

Smoke Stacks, Boiler Fronts and Hot Surfaces

"Superior Graphite Paint" No. 36 is specially prepared for this work. This paint is made from our Lake Superior graphite ore, which is itself a product of intense natural heat. It is mixed with pure linseed oil boiled to over 450 degrees. This means that the paint will not burn out and will give maximum service on hot surfaces.

Machinery

For engines, pumps, hoists, etc., we recommend Degraco Machinery Enamels. These enamels are of the highest grade, made to withstand heat and oil drippings. They may be washed and cleaned, and will hold their color to an unusual degree. Furnished in any color desired.

Galvanized Sheets on Roofs and Sides of Buildings

No. 35 "Superior Graphite Paint" is very largely used for galvanized steets, and for general use on this surface is a very satisfactory paint. It is economical because of its large covering capacity, is non-fading and durable.

Where other colors are desired we recommend our Nos. 30, 308, 55 and 57.

For the painting of newly galvanized sheets, Degraco Galvanized Iron Primer should be used before the finish coat is applied.

Fan Houses

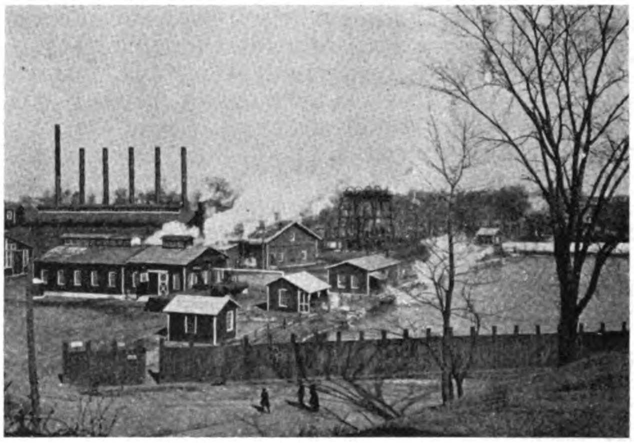
No. 30 "Superior Graphite Paint" will give the utmost protection.

Steel Mine Cars

We recommend for this work Degraco Paint No. 106. This is a special water-proof and moisture-proof paint. It is unaffected by sulphur water or any impurities found in the coal. Experience has shown that one coat of No. 106 on a mine car every year or every eighteen months will more than double its life. This paint covers well and dries quickly and hard.

Mine Piping

No. 106, referred to above, is equally as serviceable on piping as on steel cars.



Dorrance Colliery, of the Lehigh Valley Coal Co. Headframe, Boiler House, Machine Shop, Pump Room, Engine Room, Air Tanks, Reservoirs and Stacks are all painted with Degraco Paints.

Miners' Houses

We have made a specialty of Cottage colors in a large variety of shades for miners' houses. These paints are especially made so that they will not change color or fade when exposed to smoke or gases around a mine. They are made to meet mining conditions and will give maximum service. They are very durable and have a large covering capacity.

For the interior woodwork we also make special paints which are being used with excellent results in the coal mining field.

Mine Timbers

For the painting of mine timbers, trestles, flooring, wooden poles below ground level, etc., we recommend Degraco Wood Preservative. This is a material of good penetration, and consequently of good preserving qualities. Its use on timbers exposed to moisture or dampness will more than double the life of the wood. It is easily applied, covers well and is sold at an attractive price.

No. 22-B Boiler Graphite

No. 22-B Boiler Graphite is an amorphous form of graphite, ground to an impalpable fineness. It mixes readily with water, and has a natural affinity for steel.

Scale is readily removed from a boiler, and its formation effectively prevented by the use of No. 22-B Boiler Graphite.

The above products cover only a small portion of the specialties manufactured by this Company. We shall be glad to give color cards and booklets, and detailed information on them or on any other paints required.

DU PONT CHEMICAL WORKS

E. I. Du Pont De Nemours & Company Inc. Owner

Equitable Building,
NEW YORK, N. Y.

Tar Products

Du Pont Building,
WILMINGTON, DEL.

DU PONT

CARPOLENE

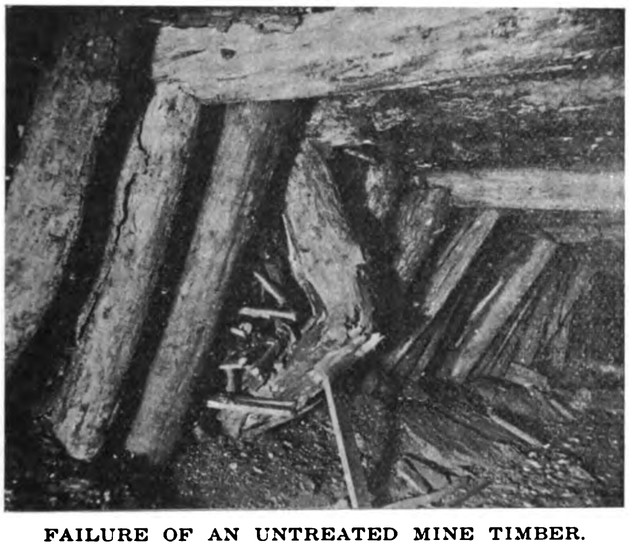
A Wood Preservative

Investigations by the U. S. Forest Service show that 50% of all mine timbers are destroyed by decay and insect attack, due to average mine conditions being exceptionally favorable to the growth of these destructive agencies.

Untreated legs, props and collars usually last less than two years. Besides the heavy cost of replacement the operation of the mine is severely interfered with.

Du Pont Carpolene offers an excellent method of preservative treatment by combining greatest permanence with maximum penetration, while possessing the necessary antiseptic or toxic properties to preclude fungus growth and insect attack.

When applied by the brush method to well selected, seasoned wood, Du Pont Carpolene assures at least double the normal life at an additional setting cost of about 5%.



FAILURE OF AN UNTREATED MINE TIMBER.
Note the Excellent State of Preservation of the Treated Timber Directly to the Left of the Untreated Broken Leg. Both were Set at the Same Time.—Courtesy of the U. S. Forest Service.

Such treatment not only makes it possible to use less timber for any given working, but also permits the utilization of inferior species of wood, which are rendered more durable by its use than the more expensive, higher grades of untreated structural timber.

Where long service for permanent timbers is required we recommend that the open tank or the still more effective pressure process be employed, since the better results obtained return large dividends for the investment made.

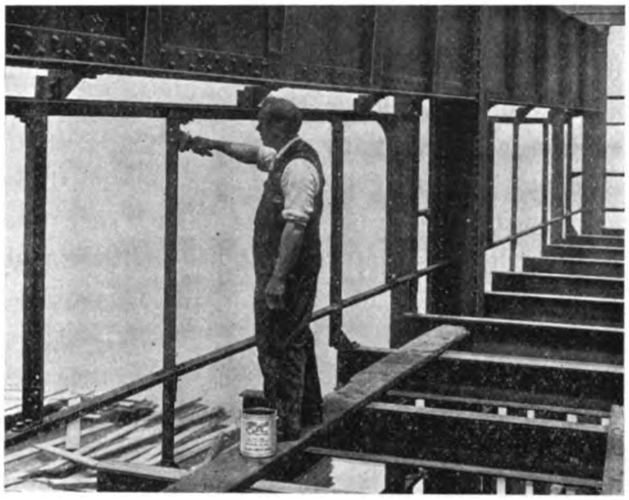
DU PONT

CARPO

A Black Metal Paint

Du Pont Carpo is a paint particularly well suited for the preservation of those metal surfaces which the damp condition of most mines renders subject to hasty deterioration. It is specially prepared to resist sulphur fumes as well as any dilute acids and alkalis present in the sub surface drainings of mine workings.

Far superior in lasting qualities to proprietary asphaltum paints, it spreads freely, evenly and smoothly at ordinary temperatures when applied by any of the usual means. Either the brush method or tank-dipping process of application may be used with equally satisfactory results.



The surfaces to be coated should first be scraped and wire-brushed of all rust, scale and loose dirt or sediment. Du Pont Carpo is then applied, producing a permanent black coating, that possesses unusual durability and resistance to deteriorating influences.

When applied to brick walls, masonry or concrete, Carpo produces a waterproof coating that will not flake or peel. Galvanized iron may be painted without fear of checks or cracks. Being non-corrosive it is exceptionally suitable for painting bridges, conveyors, buckets, hoists, cars, tipple equipment and mining machinery.

As Carpo was successfully used at the great Du Pont Mills for almost two years before being offered to the market, every claim made for it is based on actual performance.

THE KETTLE RIVER COMPANY

MINNEAPOLIS, MINNESOTA

Distributors

New York, American Chemical & Mfg. Co., 149 Broadway.
Cleveland, C. H. Hoyt, 412 Citizens Bldg.
Pittsburgh, Monongahela Wood Preserving Co., Fulton Bldg.
Chicago, James A. Kenny, Webster Bldg.
St. Louis, F. A. Bobel, 1002 Title Guarantee Bldg.
New Orleans, C. T. Patterson Co. Ltd., 801 Tchoupitoulas St.
Louisville, J. B. Wilkinson, Starks Bldg.
Portland, Ore., W. W. Gordon & Co., Ainsworth Bldg.
Beaumont, Texas, E. L. Wilson Hardware Company.
Norfolk, Va., American Chemical & Mfg. Co.
San Francisco, C. H. Johnson, Rialto Bldg.
Havana, Cuba, Thos. F. Turull, Muralla 2 y 4.

Fifty Percent

of timber bills for framing mine leads can be saved, even though such timbers are eventually abandoned.

Standing Structures

can now be preserved and given many years added life by our new efficient method, adopted by hundreds of mines.

Our Engineering Department

will show you how intelligent preservation of mine timbers, in connection with new methods of construction, will save many dollars now being wasted in timber bills; they will study each individual case and suggest methods best suited to such case; they will furnish blue-prints of suitable treating tanks which can be erected right at the mine by your own labor at little cost; they will devise methods of treating

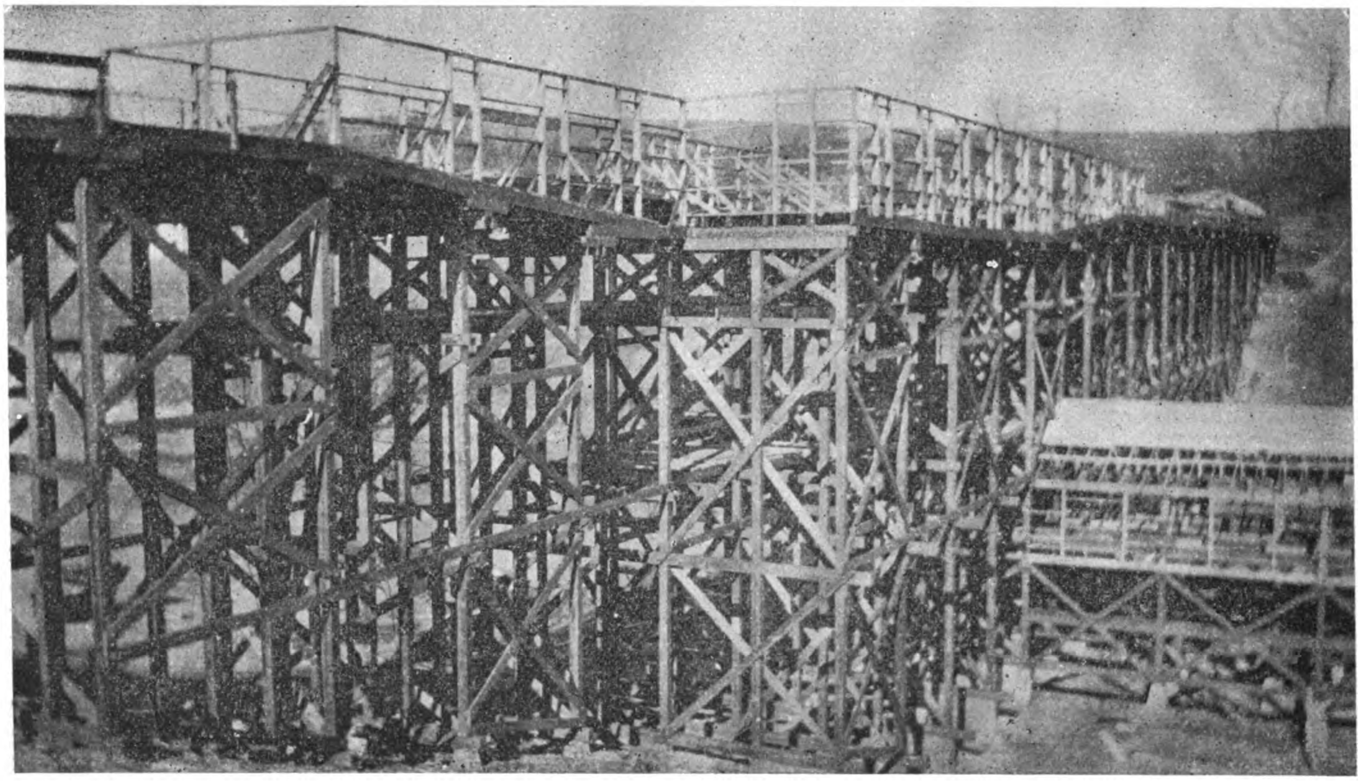
- Main Track Ties
- Posts
- Tipples to be Built
- Inclines
- Slope Timbering
- Out Buildings
- Head Frames
- Tipples Already Erected
- Trestles
- Special Timbers.

K-R Wood Preserver

It is the highest grade wood-preserver ever produced, is made in America, is non-evaporative, indestructible oil, of absolutely pure coal tar origin, and will remain in and preserve timber indefinitely.

It will not increase fire risk or decrease tensile strength of timber.

Its use will eliminate all risk of accident due to decaying and unsafe timbers.



W. W. LAWRENCE & COMPANY

PITTSBURGH, PA.

Paint and Varnish Makers

Everything Best in Paint

Being situated in the center of the great bituminous coal fields, we have, perhaps, been brought more in contact with the paint requirements of the coal mining industry, than any other paint manufacturer, and with our years of practical experience as paint makers for many of the largest coal mining companies, we have developed a line of products that will be found expressly suited for such needs.

In the following list of standardized products will be found a paint or finish that is particularly adaptable on any surface, in or about a coal mine—for buildings—tipples—cars—structural work—machinery—boilers or company houses, etc.

Company House Paint

The painting of Coal Company Houses has long been one of the preplexing problems of mine operators, but with our perfected brand of "TRY ANGLE" COMPANY HOUSE PAINT, all difficulties along this line can be easily overcome. "TRY ANGLE" PAINT is composed of the very best pigments found suitable for this class of work. It is mixed with PURE LINSEED OIL, and is offered in a variety of good substantial colors that are both attractive and durable.

No. 1505 Red Lead Preservative

After years of scientific research, we have perfected a Red Lead composition that will neither harden, nor settle quickly in the package.—A composition that affords the greatest protection for all metal surfaces and one that covers an unusual amount of surface on account of its easy spreading quality.

No. 2010 Black Carbon

A Pure Carbon and Red Lead mixture, especially suitable for a finishing coat over No. 1505, but can be used alone with excellent results on any metal surface where protection from the weather elements is essential.

Black Stack Paint

The LAWRENCE BLACK STACK PAINT is made expressly for Smoke Stacks, Boiler Fronts, and other surfaces that require a heat resisting coating, is jet black, and a very durable finish for this class of painting.

Machine Enamels

The Lawrence Machinery Enamels "High Gloss" resist the action of oils and grease, are heat-proof, and come in a variety of colors—made especially for finishing Engines, Pumps, Etc.

Graphites

The LAWRENCE GRAPHITES are made of PURE GRAPHITE and PURE LINSEED OIL only. They are ground extremely fine, which adds to the spreading qualities and consequently cover more surface than ordinary Graphites.

Oxides

The LAWRENCE RED OXIDE No. 38 is made of PURE IMPORTED OXIDE of IRON, and is ground and thinned with PURE LINSEED OIL, and will meet the most exacting demands for those desiring a moderate priced protective paint for either wood or metal.

Black Metallic Paint

BLACK METALLIC is a very low priced Black coating that will be found useful for all ordinary painting on either iron or wood surfaces.

Cementect

The LAWRENCE CEMENTECT FINISHES will be found to render the best service for protecting all kinds of CEMENT or CONCRETE work—Exterior or Interior.

Lawrite Acid Proof Paint

A coating scientifically prepared to protect surfaces that are subjected to the action of acids or gases—an acid-resisting paint for either wood or metal surfaces.

We have prepared special booklets on most of the foregoing, which will be sent on request.

We invite correspondence and offer free to mine operators the services of our chemical laboratories, that will help solve any preplexing paint problem that may arise from time to time.

THE NATIONAL PAINT & VARNISH CO.

Manufacturers of

High Test Paints & Varnishes

CLEVELAND, OHIO. U. S. A.

Products

National Tinners Red for Metal Roofs, etc.; National Graphite Structural Paint for Structural Iron and Steel; Coatolite, an enamel paint for making interiors light; National Flat Wall Enamel, a sanitary, washable interior flat finish.

We also make special paint for Bridges, Machinery, Metal Tanks, Boilers, Stacks, Gas Holders and Structural Iron and Steel, Tipples and Breakers, Wooden Tipples, Fan Houses, Mine Piping, Miners Houses, Mine Timbers, etc.

Asbestocote, a long fibre asbestos coating (paste or liquid) for re-roofing or repairing old Roofs and for waterproofing foundations, etc.

Cementone, a waterproof coating for protecting and preserving Concrete, and Plaster surfaces.

All our paints are guaranteed for the specific purpose recommended and our best claim to your consideration, is our 20 years successful specialization in the manufacture of protective metal paints.

National Graphite Structural Paint

We absolutely guarantee these special paints to be damp resisting, anti-corrosive and preservative.

For one coat work, we recommend our No. 41. A paint of great hiding power, elasticity and covering capacity.

For the two coat work, we recommend our No. 42. A pure graphite paint tinted with the highest grade oxide as a first coat, and for the second coat our No. 41 as described above.

National Graphite Structural Paint covers 600 square feet per gallon.

National Tinners Red

A strictly scientific protective paint for Tin, Corrugated Iron and Steel, Galvanized Iron and other exposed Sheet Metal surfaces.

National Tinners Red contains no driers. It dries naturally, in from 6 to 8 hours, due to a combination of oils used in its manufacture.

It spreads easily, has a covering capacity of 600 square feet per gallon on new metal, retains its elasticity and durability, will not crack, chalk or peel and is not affected by moisture, heat, cold, dust, acids, alkalies, fumes, smoke, cinders, etc.

On account of its great covering capacity and durability, it is the most economical sheet metal paint on the market.

Coat-o-lite

This is an intensely white coating, which covers like paint but dries with the gloss and whiteness of porcelain.

Coat-o-lite looks and wears like porcelain, it can be wiped or washed as clean and sanitary as the surface of tile and it becomes whiter with age.

Coat-o-lite will never crack, chalk, nor flake as it maintains its elasticity under vibration, steam, moisture, heat, cold, acids, alkalies, greases, fumes, etc.

Surfaces on which Coat-o-lite is to be applied should be cleaned free of dirt, grease, finger marks, etc., before application. As Coat-o-lite is opaque, it will cover up ordinary surface deficiences.

Asbestocote

Asbestocote is a scientific chemical structure of natural moisture repellents, into which everwearing fibres of asbestos are meshed by our process.

The result is a tough, elastic, waterproof, preservative roofing which can be applied by any inexperienced person over **any old roofing surface** with a brush or trowel.

Consistent Results—When Asbestocote is applied to old roofing surfaces all further rust, corrosion and decay are immediately arrested. The material bonds adhesively to Wood, Shingles, Tin, Iron, Steel, Felt, Canvas, Paper, Slate, Brick, Tile or Concrete.

Characteristic Facts—Two factors of consideration in the selection of a roofing material are—weight and appearance.

Asbestocote is applied with a brush or trowel, to 1/32 and 1/8 of an inch respectively, hence its weight distribution is so slight as to be negligible.

Asbestocote makes a pleasing, uniform roof surface, in no way disfigured by laps, seams or joints.

Asbestocote will lay flat and uniform at any slant, angle or perpendicular, and will not melt, run, blister, crack or peel under any climatic changes.

Certain Satisfaction—Asbestocote is highly elastic and resilient, hence expands and contracts with all surfaces.

Asbestocote is inert, hence is not affected by acids, alkalies, gases, fumes, smoke, steam, sparks or cinders.

Asbestocote is so adhesive, it can be applied to a damp surface in an emergency.

Quality

Automatic machinery guarantees uniform grinding and mixing of all National Paints and Products.

Sample quantities from each batch are separately tested, chemically, mechanically and under exposure.

Every precaution is taken to see that National Products, are applied in shop or on the job in a manner conducive to best results.

Efficiency

National Graphite Structural Paints and National Tinners Red, are shipped in our patented steel agitator barrels which assures uniform application in shop or field, avoids loss from leaks, waste, and paint skins and keeps the paint free from dirt, snow, rain, etc., during application.

We will ship our paints in wood or steel containers, with or without agitator equipment if so desired but in the interest of economy and efficiency we advise our patented steel agitator barrel, for which we allow full purchase price when returned to us in good condition.

Conclusion

Our engineers or chemists will be glad at any time to help you solve any special paint problems.

We will gladly furnish samples for comparative tests.

We have specialized in protective metal paints for twenty years and our products are well known and used extensively in the Mining Industry.

THE NORTHEASTERN COMPANY

LETTENEY
Reg. U. S. Pat. Off.
WOOD
PRESERVATIVE

6 BEACON ST., BOSTON, MASS.

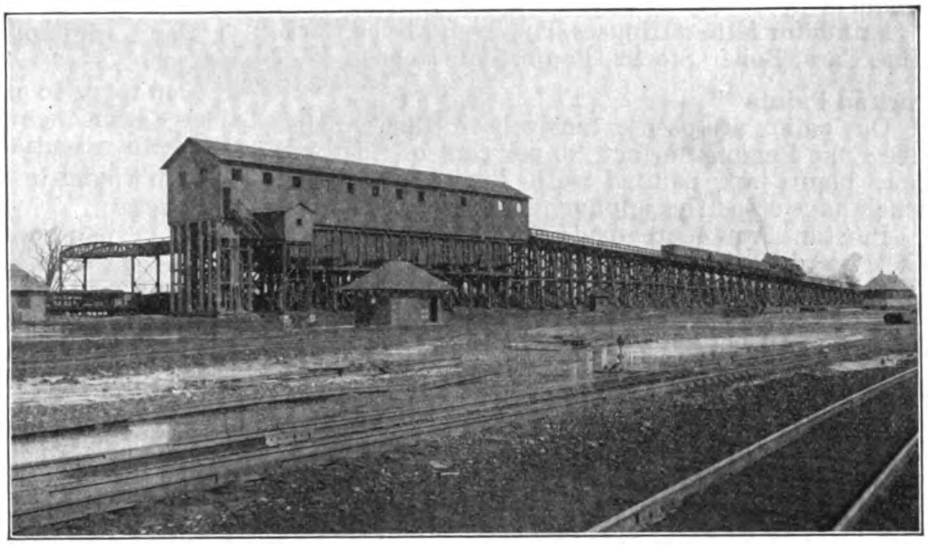
LETTENEY
Reg. U. S. Pat. Off.
WOOD
PRESERVATIVE

1103 First Ave., Seattle, Wash.
863 Camp St., New Orleans, La.
92 Wall St., New York, N. Y.
208 So. LaSalle St., Chicago, Ill.

Letteney Wood Preservative has an unequalled record for brush and open-tank treatment of timber since 1867.

In addition to the positive results in adding years to the life of wood, LETTENEY is a most attractive stain for outside use, giving a rich brown color—strikes well into the wood and does not peel off, producing results quite unobtainable with paint or any other material.

LETTENEY has shown its value in preserving the timbers of such old structures as: Meridian St. Bridge, East Boston, Built 1867; Malden Bridge, Charlestown, Built 1875; Dover Street Bridge, Boston, Built 1876; Chelsea Bridge, Boston, Built 1877.

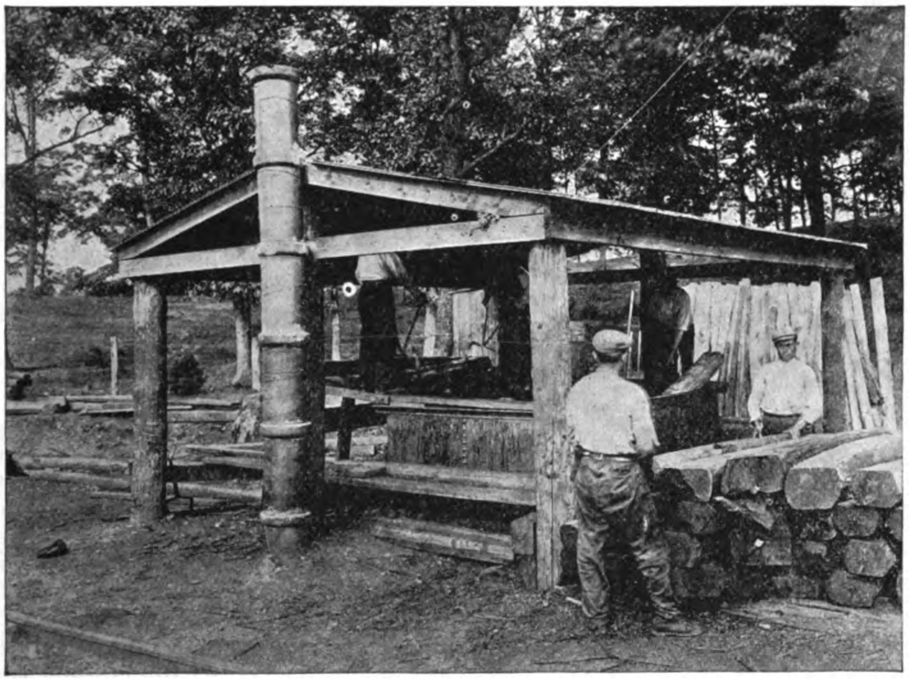


Coal Handling Plant New York Central and Hudson River R. R., Utica, N. Y. Timber treated with Letteney 1912.

LETTENEY—Has stood the Service Test of Time since 1867. Will stand the test by analysis.

LETTENEY is applied as a brush coat or by open tank treatment.

For a BRUSH COAT TREATMENT LETTENEY should be thoroughly liquid, and may be applied either hot or cold, according to weather conditions. In very cold weather it should be heated in an iron kettle to between 100° and 150°F. to keep it thin and fluid. The best practice is to apply a second coat after the first has dried in. All season checks, ends of timber, gains, mortices, and cuts of any description should be well slushed. A broad, flat, wirebound brush gives good results.



Semiportable Treating Tank Where 500 Ties Per Day Were Given a Five-Minute Dip in Letteney Wood Preservative.

For the OPEN TANK TREATMENT an iron tank, of suitable size to take the lumber, is placed with the top edge about waist high. For heating the preservative in the tank steam coils should be arranged in the bottom, or direct heat used from a fire box under the tank, with the smoke flue carried up three or four feet away, to give the men free access around the tank.

After the tank half full of preservative is heated to from 175° to 210°F. the timber is dipped into it and allowed to remain for five to twenty minutes, depending upon whether it is dry or only partially seasoned. This method is even more economical than the brush treatment when large quantities are to be treated. It also more thoroughly fills the checks, knotholes, and other defects.

PURITAN PAINT & OIL COMPANY

PITTSBURGH, U. S. A.

Manufacturers of

Paints for Miners Houses, Tipples, Etc.

Direct from Manufacturer to Consumer

Products

Paints for Miners' Houses, Tipples, Railroad Cars, Mine Cars, Boiler Stacks, Roofs, Fan Houses, Etc.

Puritan Paints

Our paints are used extensively in the Connellsville Coke Region; in fact, 90 per cent of Coal and Coke plants are painted with Puritan products, which have stood the sulphur test of this region.

Puritan Paints are made for painting houses. They are not "Patent," Chemical" or "Fireproof." They are made with pure Linseed Oil and guaranteed to wear. They are the kind of paint a painter would make when he used the very best materials.

Pure White Lead,
Pure White Zinc,
Pure Linseed Oil,
Pure Turpentine Dryer,
Pure Tinting Colors.

But by our way of making them they are better still, because modern machinery and fine grinding mills can mix and grind together the ingredients of these paints more thoroughly than can be obtained by mixing the various materials in a tub with a stick.

Concerning Colors

When selecting paint for exterior work it is well to remember that some colors are more enduring than others. The blues, pinks and delicate tints intended solely for interior work should never be used where they will be exposed to the sun. The grays, browns and yellows and the many beautiful shades and tints made therefrom are of the permanent order, and we therefore recommend their use where permanency of color is especially desirable.

Quantity of Paint Required

One gallon of ready mixed paint is usually enough to cover 200 to 500 square feet, two coats, but no definite rule can be given, as new work or old weather-beaten work will absorb more paint than a surface that is smooth and hard.

To find the quantity of paint required for various surfaces, divide the area in square feet by

400 if for moderately absorbant surface.
500 if for good surface.
600 if for tin roofing.

The result will be the number of gallons required for a single coat.

Costs

It costs no more to apply a good paint than a poor paint.

A poor paint at any time is expensive, because of the need of early repainting.

A good paint is economical because it saves the cost of repainting.

PURITAN PAINTS will reduce painting costs to the lowest figure.

Don'ts For Paint Users

Don't attempt to paint on a greasy or sooty surface.

Don't try to paint green or pitchy lumber, or after a rain, heavy dew or fog. A perfectly dry surface is essential.

Don't paint in frosty weather, or over too glossy a surface.

Don't paint over old loose or cracked paint. Scrape or burn it off.

Don't add japan to the paint to hasten drying. It already contains the right quantity of dryer.

Don't use Ochres for priming. For primer, thin each gallon of paint used with one gallon of raw linseed oil.

Don't apply paint too thick. Brush it out thoroughly. Thick coats are likely to crack or peel.

Don't wait too long between coats.

Don't expect the best results with any but a first class painter.

Linseed Oil

Linseed oil is pressed from the seeds of the flax plant, and after purification, becomes the raw oil of commerce. After being heated in contact with certain chemicals either by means of direct fire or in a steam jacketed kettle, it is known as boiled or drying oil.

The peculiar quality of linseed oil to absorb oxygen from the air, and in oxidizing to form a tough, elastic substance, gives it a special value in paint and varnish making. Any admixture with mineral oils or non-drying vegetable oils greatly impairs or wholly destroys this value.

Puritan paints successfully resist even the intense oxidizing action of modern steel. The reason why our Preserving Paints will protect steel, iron and wood from decay are obvious from the following facts. Our Linseed Oil is scientifically treated so that it does not become completely oxidized. It sets quickly and sets non-porous, and so excludes air, elements and moisture, hermetically seals the surface and adheres with a surprising tenacity.

Painting

The paint literature of the past ten or fifteen years is overloaded with controversy as to the purity of paints, but little regard being paid to the matter of chief importance in the value of paints—that is, their relative adaptability to the ends they are intended to serve. The use of paint is two-fold; to protect the surface to which it is applied, and incidentally to render such surface more pleasing to the eye. Modern paint chemistry and technical experience make it quite possible to combine these two elements of paint value without impairment of either.

REPUBLIC CREOSOTING COMPANY

INDIANAPOLIS, INDIANA

Plants:
Indianapolis, Minneapolis, Seattle, Mobile.

REILLY'S IMPROVED
PERMANENT
CREOSOTE OIL

Applied With a Brush—Makes Wood Waterproof and Rotproof

Under present conditions it pays better than ever to treat all exposed timbers with a good preservative.

R.W.P.O. (patented) is the best preservative known to us for either surface or underground timbers, where brush treatment is necessary.

It is distilled from coal tar by our special patented process and is not merely a by-product. It contains no coal tar or other adulterants.

When applied with an ordinary brush it penetrates to an unusual depth, filling both cells and fibres with an insoluble mass of oil and coating the surface of the timber.

Its exceptionally high boiling point and homogeneous character prevent separation of the lighter elements and there is practically no loss from evaporation under most trying conditions. It lasts as long as the wood.

Limpid and free-flowing at working temperatures, it can be readily and easily applied to new timbers or standing structures.

No trace of water can gain entrance—germ life is destroyed—insects are driven away.

Write For Samples

We will gladly furnish samples of any of our products together with suggestions for testing their quality. Only by subjecting them to distillation and spot tests can you thoroughly appreciate their superiority.

Reilly's Improved Permanent Creosote Oil (patented) is by far the best product ever developed for use with the empty cell process of treating timbers. It has three times as much permanent body as the next best product. Samples on request.

R.W.P.O
Reilly's
Wood-
Preservative
Oil—
PATENTED

We have the goods and can make shipments. Write for prices and full particulars.

THE SHERWIN-WILLIAMS CO.

601 Canal Road, N. W.
CLEVELAND, OHIO

Factories:
CLEVELAND, CHICAGO, NEWARK,
MONTREAL, LONDON, ENG.

Sales Offices and Warehouses in Principal Cities.

Paints, Varnishes, Wood Preservatives

To meet the paint requirements of Mine Owners and Operators, the Sherwin-Williams Company has thoroughly investigated the conditions surrounding the industry and as a result have developed a line of materials particularly adapted to meet the severe and widely differing destructive influences to which such paints are subjected.

Our facilities for producing just the right product for each specific purpose are unequalled in the paint and varnish field. The sources of supply of many of the most important raw materials are controlled entirely by us, operating five factories for the production of paints and varnishes—tin can factory, box factory, mines and smelters, and other essential raw material producing units.

Each product is designed for the particular use specified and will economically and effectively produce the best results.

S-W Mine, Mill and Factory Colors

Sherwin-Williams Mine, Mill and Factory Colors are recommended for decorating and preserving exterior surfaces where a durable oil paint is required at moderate cost. Used largely where operators desire to maintain standard uniform colors at various plants, employees houses, etc. (See Plant Standardization Plan on next page).

S-W Metalastic (Liquid)

Sherwin-Williams Metalastic is a special compound of graphite and other materials with strictly pure linseed oil and a special drier for the protection of structural steel, tipples and breakers. It is extremely durable. Particularly adaptable where conditions of use require rapid and hard drying qualities, such as structural steel and other metal surfaces that must be handled soon after painting; on roofs where a slow drying paint could not be satisfactorily used, and on all other surfaces subject to abrasion.

Put up in quart, half-gallon, gallon and five-gallon cans, also barrels. Colors: Black, Brown, Gray and Green.

S-W Non-Corrodible, Acid-Resisting Paint

A splendid anti-rust paint with graphite for its pigment base. It will be found very durable and economical for metal surfaces. It is a scientifically prepared coating for use on metal surfaces subjected to the action of gases, acids or their fumes, salt water, ammonia, and other disentegrating agents. Especially adapted for use on smelters or buildings adjacent which are subjected to sulphuric acid fumes, and similarly exposed locations. Put up in gallon pails, five-gallon square tin cans and barrels.

S-W Galvanized Iron Primer

Prepared ready for use. This is a paint for priming or first coating galvanized iron and sheet metal surfaces, metal sash and trim, cornices, finials, leaders and in fact any galvanized iron surface. It is a perfect undercoating and can be successfully applied to galvanized iron and sheet metal surfaces. It is made especially for high class work and subsequent coats of S-W Metal Protective and oil paints are recommended. Made in gray only. Put up in quart, half-gallon, one gallon round cans, five-gallon square cans and barrels.

S-W Roof and Bridge Paint

An economical paint for roofs, bridges, barns, fences, etc., of metal or rough lumber.

S-W Carbon Paint, Red Diamond Brand

Absolutely the best chemically inert carbon metal protective paint possible to manufacture. Produces a homogeneous film which insures maximum protection.

S-W Salamander Smoke-Stack Black

Especially made for boilers, smoke-stacks and surfaces subjected to great heat. Elastic and very durable.

S-W Gas Engine Enamels

Especially adapted for finishing machinery, engines, and all metal work, etc., where a rich gloss elastic finish is desired. Does not become brittle nor mar easily.

S-W Graphite Pipe Joint and Gasket Compound

A practical advantageous material indicated by its name. It makes a perfectly tight joint with less labor and cost than red lead and other materials, and in addition allows the various fittings on which it has been used to be uncoupled without loss or breakage characteristic of red lead, cement or rust-set joints. Does not become hard in the package.

S-W Lustral Enamels

Designed particularly for use on wood and metal surfaces, where an elastic high gloss enamel finish is desired. Constructed to withstand severe usage to a maximum degree. Made in a number of attractive shades.

S-W Brighten Up White
(Under-coat and Finishing)

For use on building interiors, etc. The intense whiteness makes it particularly adaptable for use in dark corners for reproducing refractory light. It will be found an invaluable agent for efficient lighting in your building interiors. Made in gloss and egg-shell finishes. Put up in 1 gallon and 5 gallon containers, also barrels.

S-W Ajax Insulating Varnishes and Compounds

In Ajax Insulating materials we offer a complete line of Insulating Varnishes, both Air Drying and Baking Compounds, Acid Resisting Paints, Spirit Varnishes, etc. The same care that is used in the manufacture of our entire line of Paints and Varnishes is used in the production of our Insulating materials. The raw materials are selected with the greatest of care by experts in this line and are combined in a way that only long experience, careful research and a full knowledge of the business can teach.

Every batch is carefully tested in our well equipped laboratories before shipment is made for heat resistance, oil proof and moisture proof qualities as well as dialectric strength.

This pains-taking care that is used both in the manufacturing as well as the testing of S-W Insulating materials assures a product that at all times will meet the exacting requirements of users of electrical equipment of all kinds.

S-W Preservative Shingle Stain

An exceptional line of Shingle Stains made on a Creosote basis for use on shingle roofs and all shingle parts. Is also well adapted for stables and out buildings as it is an excellent wood preservative as well as a strong disinfectant.

S-W Ebonol

An economical Black Elastic Paint for use on paper, composition, felt and canvas roofing and on exterior equipment of any sort where an economical paint is desired. Can be used on tin roofing as it absolutely contains no acids harmful to the metal. Is also adapted for use on rain water tanks, standard pipe, sluice-boxes, water troughs, gutters, copings, fences, etc.

Ebonol has excellent covering capacity, works well under the brush and will stand the out-door exposure.

S-W Elastic Roof Cement

Without doubt the most durable and economical roof cement on the market today. For use in repairing all leaky roofs, can either be used for patching or can be spread over the entire roof, making practically a new roof at a very small cost. Cracks and holes in brick, stone, concrete, chimneys and other exposed surfaces can be sealed up with comparatively little trouble by using this material. It is made on a pine tar basis with long asbestos fibre as its pigment, which makes it fire-proof.

Elastic Roof Cement will remain plastic in all temperatures, will not run in the hot summer sun or crack in freezing temperatures. Put up ready for use in 1, 5, 25 and 100 pound containers and barrels.

100 square feet of roofing will require from 25 to 50 pounds.

S-W Carbolic-Ol—A Wood Preservative

Carbolic-Ol is a pure anthracene oil derived from the distillation of pure coal-tar, or in other words, the heaviest oil produced from the distillation of coal-tar and what is known as a high boiling point oil. The distinction between an anthracene and creosote oil is that the latter distills at a low temperature, consequently is lighter in gravity; more volatile, and generally recognized as not being efficient for the types of work for which we recommend Carbolic-Ol. Particularly recommended for use on poles, shaft timbers, trestles, flumes, tipples, airshafts, sheds, etc.

Carbolic-Ol can be sprayed, dipped or brushed and where possible, dipping is preferable, heating the material is about 200 degrees Fahrenheit. It is always preferable to heat a wood preservative before applying as this greatly assists the impregnation of the wood.

S-W Concrete and Cement Hardener

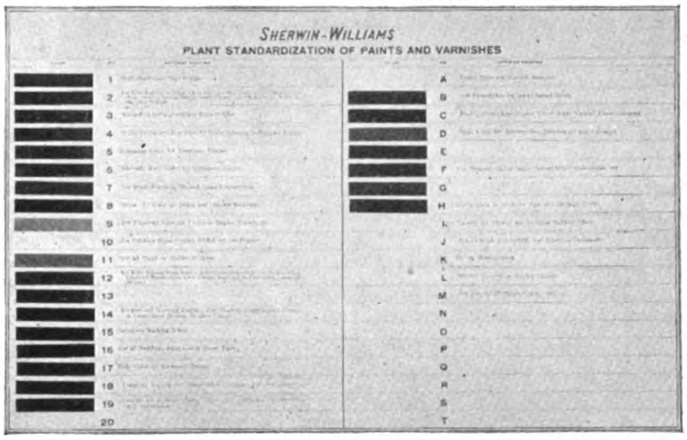
An effective preparation for hardening and water-proofing cement. The value of using a preparation for hardening and waterproofing cement cannot be overestimated. Cement, the same as all other materials, is subject to wear and decay from the elements unless properly protected. By filling up the open pores or voids with S-W Concrete and Cement Hardener, the cement may be greatly strengthened or hardened, thus giving it much better wearing properties. The elements have no effect on S-W Concrete and Cement Hardener, as after the pores of the cement are filled with this material the cement becomes permanently and thoroughly waterproof.

S-W Petriloid

An excellent water-proof, alkali-proof, acid-proof and damp-resisting, glossy black composition, used for hermetically sealing concrete and stone surfaces against the detrimental agencies mentioned.

S-W Plant Standardization Plan

We have a plant standardization plan of special interest to mine operators. (See sample below). Complete information of this plan together with a system worked out for your use will be submitted on request.


SHERWIN-WILLIAMS
PLANT STANDARDIZATION OF PAINTS AND VARNISHES
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It is of course impossible to describe our entire line of products in these columns, only a small percentage being mentioned here. However, we make a special paint for every surface and are prepared to furnish at once and in any quantity just the right product for any purpose. We will be glad to solve specifically any paint problem confronting you.

UNITED STATES VARNISH CO.
UNITED STATES ROOFING CORP.

41 PARK ROW, NEW YORK

- Acid Proof Paints
- Acid Proof Compounds
- Non-Corrosive Coating
- Pipe Coating
- Electrical Paint (Acid Proof)

- Prepared or Ready Roofing
- U. S. Roofing of the CLASS KNOWN AS RUBBEROID ROOFING
- Low Priced Prepared Roofing
- Building and Insulating Paper
- Roof Paint (Acid Resisting)

Products

We are specialists in the manufacture of quick drying paints and compounds, that prevent destruction caused by acidulous waters, fumes, steam, dampness and weather conditions, in and around mines.

If you will tell us your particular troublesome conditions you will find we have a product to remedy it.

U. S. Acid Proof Paint

This paint will prevent destruction caused by acidulous waters and fumes in any strength. It will adhere to, and protect any surface. It contains no asphalt, oil, coaltar or pigments. Although it is applied with a brush and air dries in about 15 minutes it will not crack, crumble or become brittle. The paint is a natural black and will stand a temperature of over 350 degrees Fahr.

U. S. Acid Proof Compound

Our compound is used as a protective coating. It will adhere to any surface and will positively stand up against the most severe conditions of acids, alkalis, acidulous mine waters, dampness, smoke, steam and weather.

U. S. Preservative Paint

This low priced non-corrosive coating is made in black and is a wonderful protection for metal work of all description in and around the mines—it will also protect all wood work, concrete and all kinds of roofs against the action of acid fumes, acidulous mine waters, dampness, smoke, steam and weather conditions.

U. S. Electrical Paint

This paint is used by many of the largest concerns for the following reasons:

1. Not affected by acids, alkalis or their fumes.
2. Air dries in ten minutes or less (no baking).
3. Remains as flexible as rubber indefinitely.
4. Not sticky and cannot be powdered.
5. Has a patent leather gloss and finish.
6. Has an official puncture test of about 10,000 volts A. C. on one ordinary brush coat of about 6 mils according to Electrical Testing Laboratories, N. Y.
7. Will stand continuous heating and cooling at a temperature of over 400 degrees Fahr. without deterioration.
8. Has a wonderful penetrating quality.

Products

We manufacture the highest grade prepared roofings the prices of which are reasonable.

We also manufacture lower priced roofings.

Our Insulating and Building Paper is a product of quality.

We manufacture a roof paint low in price that can be used on any kind of roofing at the mines.

Class Known As Rubberoid Roofing

This is the best grade of prepared roofing that is manufactured and is

Guaranteed

One ply 5 years
Two ply 10 years
Three ply 15 years.

Our prices are very reasonable and lower than many other roofings of inferior quality.

We manufacture this same roofiing in rolls with red and green crushed slate finish. This makes a very artistic, highly fire resisting and durable roofing.

The crushed slate shingles, which we also make, are of course much superior to wooden shingles and very little higher in cost.

Durus Roofing

A good substantial, low priced, smooth surfaced prepared roofing that will last for years and keep down the cost of construction.

Owl Insulating and Building Paper

A wonderfully good asphalt saturated and coated paper, reasonable in price, not affected by fumes, steam, dampness, weather, etc.

U. S. Roof Paint

This product is made of the highest grade material, and is quick drying. It contains no oil, asphalt, coal tar or pigment, and will make a tough, rubber like coating **on any surface**, that will last for years.

It is positively not affected by heat, cold, weather conditions, acid fumes, steam, etc.

Baltimore Roofing & Asbestos Mfg. Co.

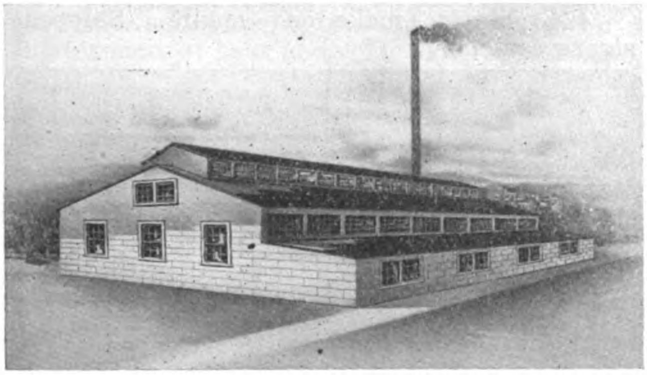
ASBESTOS, MARYLAND
Offices and Factories

TRADE MARK REGISTERED
BRAMCO

Roofings, Building Papers, Asbestos Millboard, Paper and Cements

Roofing Products

Bramco-bestos—A highly fire-resisting patented composition roofing consisting of the best grade of rag felt roofing insulated on the under side with a heavy fire-screen of unsaturated asbestos. Applied with black side to weather on roofs and white side to weather on siding. By applying asbestos side next sheathing boards, the fire-resisting feature of the roof is protected against any possible action of weather during the life of the roof, and there is no possibility of the asbestos sheet peeling off. Embraces the best features of both the rag felt and asbestos felt types of roofing. Furnished in two weights, 55 and 75 lbs. per 108 sq. ft., the former in rolls 32 inches wide, and the latter in sheets 32 x 82 inches. Approved and labeled by National Underwriters.



Bramco-bestos, Black Side to Weather on Roof, and White Side to Weather on Siding.

Pathfinder—A mica-surfaced asphalt roofing for permanent buildings where freedom from painting and maintenance is a factor. Unusual service is embraced in the offer of the manufacturers to issue a written guarantee that it will wear without paint for eight, ten or twelve years, according to thickness. Furnished in three weights, in rolls 32 inches wide containing 108 square feet, complete ready to lay. Approved and labeled by National Underwriters.

Bramkote—A long-life asphalt roofing on which the manufacturers offer to issue a written guarantee that it will wear for five, ten or fifteen years, according to thickness. Especially suitable for use on mine tipples, washeries, power houses and similar buildings. Furnished in three weights, in rolls 32 inches wide containing 108 square feet, complete ready to lay. Approved and labeled by National Underwriters.

Bramco Slate-surfaced—A heavy asphalt roll roofing surfaced with crushed slate of red or green color, offering a most attractive covering for the better types of buildings. The color is absolutely permanent and never needs renewing. Furnished in one weight only, in rolls 32 inches wide containing 108 square feet, complete ready to lay. Approved and labeled by National Underwriters.

Bramco Slate-Surfaced Shingles—These are made of the same material as our slate-surfaced roll roofing, but offered in shingle form, each shingle 8" x 12¾" in size. Because of their permanence of color, attractive appearance, wearing qualities, flexibility, resistance against fire and low upkeep, these shingles are rapidly replacing wooden shingles and slate. They should be laid with a four-inch exposure to the weather, producing a triple thickness over the entire roof. Supplied in cartons 424 shingles to the square, sufficient to cover 100 square feet of roof. Approved and labeled by National Underwriters.

Asbestos Products

Asbestos Millboard—A superior insulation in sheet form against fire, heat, cold, chemical fumes and vermin. Furnished in stock sizes of 40 x 40-inch, 42 x 44-inch, 44 x 48-inch and 48 x 48-inch, and in any thickness from 1/32 to 1 inch. Special sizes cut to order.

The Complete Bramco Roofing Line.

Asbestos Rollboard—A rolled Millboard, furnished in rolls 36 inches wide and in three thicknesses; 1/16-inch, 3/32-inch and ⅛-inch.

Asbestos Paper—A lighter weight insulation furnished in rolls 36 inches wide and weighing approximately 100 lbs. Furnished in the following weights: 6 lb., 8 lb., 10 lb., 12 lb., 14 lb., 16 lb. or 1/32-inch thick, 30 lb. or 1/16-inch thick, 45 lb. or 3/32-inch thick, and 60 lb. or ⅛-inch thick.

Asbestos Cements—For boiler, pipe and other forms of insulation, Bramco Asbestos Cement is offered in five grades each adapted to particular uses, from high pressure steam lines to low pressure hot water pipes.

THE PHILIP CAREY COMPANY

General Offices,
LOCKLAND, CINCINNATI, OHIO
Factories,
Lockland, Cincinnati, Ohio Plymouth Meeting, Pa.
50 Branch and Distributing Points.

Products

Carey Flexible Cement Roofing; Rubber and Prepared Roofings; Asfaltslate Shingles; Carey Built-Roofing Specifications; Waterproofing and Insulating Felts; Percoproof Dampproofing; Elastite Expansion Joint; Magnesia Steam Pipe and Boiler Coverings; Roof Repairing and Slaters Cement; Ceil-Board, the modern wall board; Roofing Paints for all styles of roofing; Asbestos and Asphalt Materials for every purpose.

All Carey Roofing Products are classified and approved by Underwriters' Laboratories.

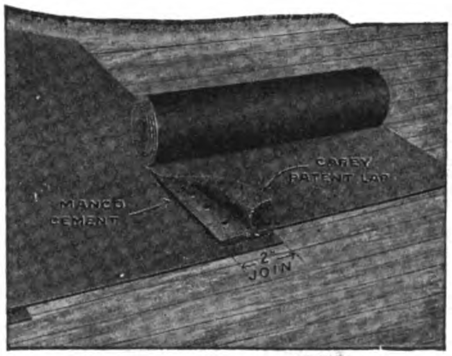
Carey Flexible Cement Roofing

The oldest prepared roofing on the market. Many thousands of squares are in use throughout the Coal Fields in all sections of the United States.

Carey Flexible Cement Roofing is made in sheets 36 inches wide and 36 feet long, sufficient to cover 100 square feet surface measure. It weighs 106 pounds per square with the completing materials.

The Carey Patent Lap

One of the strong features employed in the application which seals the sheets securely together.



Joints are absolutely watertight and windproof. Carey Roofing has stood the test of more than 30 years.

Construction

Carey F. C. Roofing is made almost entirely of the Carey Flexible Asphalt Cement Composition reinforced with strong Calcutta Burlap and pure Asphalt saturated wool felt. These materials are combined in a firm flexible sheet which cannot dry out nor lose its form under exposure to any temperature of the sun's heat. It is the only roofing produced that can be relied upon to retain its flexibility permanently.

Equally adapted to flat or steep surfaces and for use on all types of buildings—wood, concrete, tile or Gypsum block roof construction. Specify Carey where a permanent roof is important.

Price and full information will be furnished from nearest branch or distributing point.

Carey Built-Roofing

We contract to furnish and apply Carey Built-Roofing in accordance with specifications anywhere in the United States. Carey Built-Roofing Specifications are prepared to meet the requirements of any type of construction. Both workmanship and materials are fully guaranteed.

Send for Specification book.

Carey Asfaltslate Shingles

Natural colors, red or green. Non-fading.

424 shingles make one square. Shipped in strong cartons.

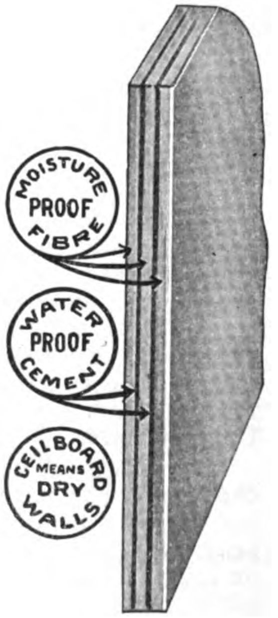
Carey Asfaltslate Shingles. The Roof Beautiful.
Average weight 240 lbs. per square. Send for samples.

Carey Ceil-Board

Used instead of lath and plaster in making walls and ceilings.

Ceil-Board is made of three sheets chip board bonded together with pure asphalt cement; internally and externally sized. Its insulating qualities are four times as great as lath and plaster. Quickly and easily applied, durable, practical and economical. No expense for upkeep. Furnished in sheets 32 and 48 inches wide; in lengths of 5 to 16 feet. Five finishes: Gray, Tan, Mission Oak, Golden Oak and Circassian Walnut.

Complete details, cost and other information upon request.



Information

For complete information respecting Carey Roofing Paints, Carey Repairing Cements, Steam Pipe and Boiler Coverings or other building materials in the Asbestos or Asphalt line, write us direct. Inquiries will receive prompt attention.

Certain-teed Products Corporation

General Roofing Mfg. Co. Mound City Paint & Color Co. Gregg Varnish Co.

Certain-teed

Sales Offices:

PITTSBURGH **ST. LOUIS** **CINCINNATI** **PHILADELPHIA** **CHICAGO** **KANSAS CITY** **ATLANTA**
NEW YORK CLEVELAND SAN FRANCISCO NEW ORLEANS SEATTLE RICHMOND LONDON
BOSTON DETROIT LOS ANGELES MINNEAPOLIS INDIANAPOLIS HOUSTON SYDNEY
BUFFALO MILWAUKEE GRAND RAPIDS NASHVILLE SALT LAKE CITY DULUTH HAVANA
DES MOINES

Roofings Paints Varnishes Sheathings

Certain-teed Roofing (1, 2 and 3 Ply Talc-surfaced)

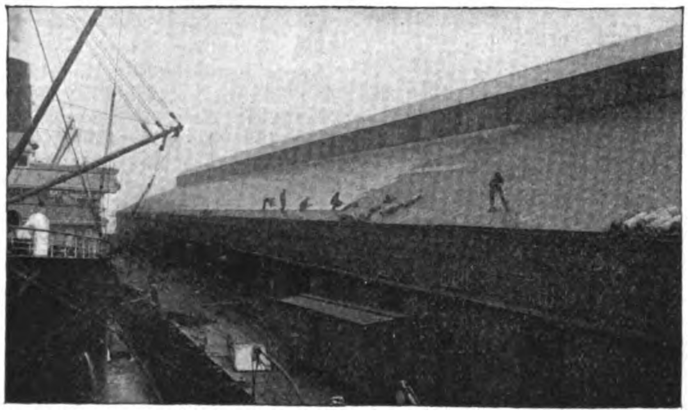
This is the modern low-cost roof. It costs less to buy than any metal or wood shingles, and the application is simple—care rather than skill is the important factor. It can be laid on any surfce, steep or flat; it can't rust, it is fire retardant, it is proof against fumes and gases, it is sound deadening and it insulates against heat and cold. The saturation is a blend of asphalts that is proof against fumes, gases and acids, and that is non-volatile—it has extraordinary resistance to the drying-out action of the sun and to every other form of disintegration. Made of soft, absorbent, rag-stock felt specially formed to carry abundance of saturation, the life of the roofing. The "soft center" for which **Certain-teed** is noted is a reservoir of surplus saturation—of reserve life. Guaranteed in writing, 5, 10 or 15 years for 1, 2 or 3 ply. Put up in rolls 32 inches wide containing 108 sq. ft. (8 sq. ft. for laps). Each roll includes Nails, Lap Cement, and full directions for laying, and weighs about 35, 45, and 55 pounds for 1, 2, and 3 ply, respectively packed complete.

Certain-teed Roofing (Red or Green Slate-surfaced)

To provide a colored roof that is permanent and yet inexpensive **Certain-teed** Roofing is made with red or green crushed-slate surfacing. This material is particularly suited for cottages, garages, offices, stables, and the like. It is 32 inches wide and is put up in 1 square rolls of 108 sq. ft. each (8 sq. ft. for laps). Each roll contains Nails, Lap Cement, and full directions for laying and weighs about 85 lbs. packed complete.

Certain-teed Shingles, Asphalt. (Red or Green Slate-surfaced).

For sloping Roofs the ideal covering is **Certain-teed** Asphalt Shingles. Their red or green is the natural color of the crushed slate surfacing, and as this color is unfading there is no expense for staining or painting. These shingles are much lighter than slate, and they cost less than half as much. They are flexible, never chip or break, readily conform to angles and curves, are easily trimmed to fit turns and odd spaces, and being of uniform size are laid rapidly and without waste. Size 8 x 12¾ inches. Laid ½ inch apart and 4 inches to the weather—making triple thickness; full directions furnished. 424 shingles cover 1 square (100 sq. ft.). Packed two crates to the Square. Weight about 240 lbs. to the Square (crated).



Pacific Steamship Company's Pier at Seattle.
100,000 Square Feet of 3-Ply Certain-teed Roofing.

Certain-teed Paints and Varnishes

This line is complete—there is a **Certain-teed** Paint and a **Certain-teed** Varnish for every surface and for every sort of interior and exterior work. These are high quality products at medium prices. In the paint the ingredients used are standard. The formula is above standard—the analysis is on every can and speaks for itself. The processes are probably not equaled by any other paint maker—a prolonged period of careful mixing and grinding gives **Certain-teed** a superior smoothness, and a continuous agitation until the can is filled insures uniformity of product in all cans. The facilities are for production on such a scale that costs are reduced to the minimum. Equal care is taken in making Certain-teed Varnish. To specify **"Certain-teed"** for any paint or varnish needed is to make sure of superior quality at a reasonable price.

Certain-teed Insulating Paper

This is a sheathing and insulating paper for the highest grade work. It is perfectly waterproof. Made of very strong-fibred paper saturated and coated with the Certain-teed blend of asphalts. It is odorless and tasteless. The most practical and best all around sheathing for lining houses and other buildings. Lasts and remains water-proof for years.

Certain-teed Plastic Roofing Cement

This is a perfectly water-proof cement, plastic in form and applied like putty. Cracks, crevices, breaks, and holes, or weak, worn or rusted spots can be filled or plastered over with this cement and a complete stop to leaks or seepage is effected in a minute's time. It adheres to any surface. For repairing roofs, gutters, valleys, downspouts, pumps and drains, for pointing up chimneys, for stopping leaks in troughs, sealing cracks in cisterns, waterproofing basements, for a thousand uses this material effects quick, easy and lasting repairs. In 1, 10, 25, and 50 pound cans, and in half and full barrels.

Certain-teed Wood Preservative. (Creosote)

The life of mine timbers and all other wood used underground or exposed to dampness is multiplied by treating with Certain-teed Wood Preservative. It prevents decay, fungus growth, and attacks by insects. It is inexpensive and using it is a practical and effective economy.

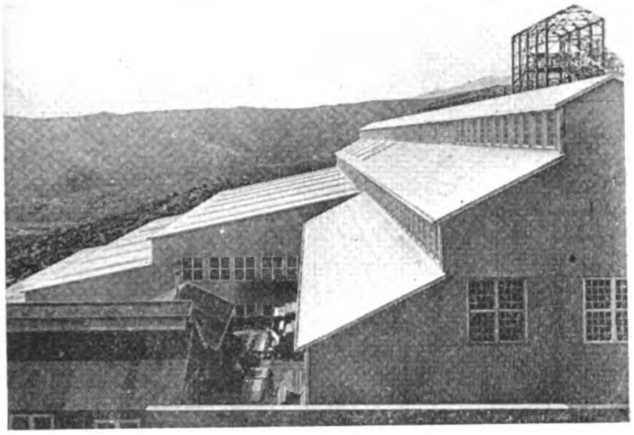
Felts, Sheathings, Etc.

This line includes **Certain-teed** Asphalt Felts, **Certain-teed** Tarred Felts, and all building papers such as Rosin-sized Sheathing; Blue Plaster Board, Deadening Felt, and Carpet Lining, also Pitch and all other coal-tar and asphalt products.

H. W. JOHNS-MANVILLE CO.

NEW YORK CITY

10 Factories—Branches in 55 Large Cities.



Miami Copper Co.

Johns-Manville Asbestos Roofing

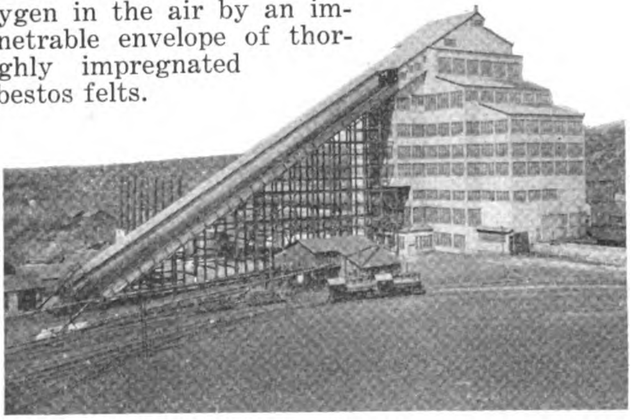
The severe conditions encountered in mine service, which so quickly weaken ordinary roofings, have practically no effect upon Johns-Manville Asbestos Roofing. It is literally a sheet of flexible stone, made of asbestos rock and natural asphalts.

There are many instances where this roofing has withstood the acid conditions encountered in mine service and around coke ovens for over 15 years. In addition to this, it has successfully resisted the attacks of time, fire and weather with little or no upkeep expense, proving beyond question that it is the cheapest roofing obtainable when figured on a cost-per-year basis.

Made in rolls and sheets ready to lay; or built up on your roof deck by representatives from the Johns-Manville Branch nearest you.

Johns-Manville Corrugated Asbestos Roofing

Johns-Manville Corrugated Asbestos Roofing cannot rust, because its metal reinforcement is armored against the admittance of the moisture and oxygen in the air by an impenetrable envelope of thoroughly impregnated asbestos felts.



Markle Co., Coal Breaker, Jeddo, Pa.

These asphalt-impregnated sheets on both sides of the iron are securely and literally keyed together with asphalt through the perforations of the metal.

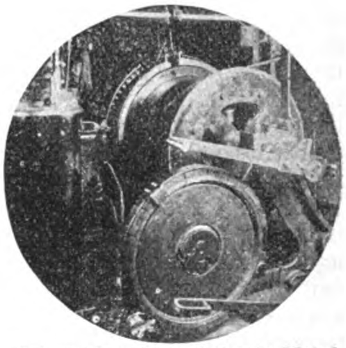
The edges are then sealed with impregnated tape which keeps moisture, air, gases or any influence that leads to the corrosion of iron from coming in contact with this reinforceing metal.

This construction insures a roofing that offers resistance to fire and the elements—one that cannot be affected by gases, smoke or salt air—and one that reduces cost for upkeep to a minimum.

Johns-Manville Asbesto-Metallic Brake Blocks

Johns-Manville Asbesto-Metallic Brake Blocks and Clutch Facings are made of asbestos fibre, wire and a binding compound, moulded and vulcanized under enormous pressure into blocks or discs of suitable dimensions.

Their frictional qualities are exceptional. They will not char, burn or slip, nor will they score the brake drum or clutch face. They react perfectly under any braking operation—from a gradual stop or acceleration to a sudden jam and reverse.



Johns-Manville Asbesto-Metallic Brake Blocks installed on Skip Hoist, Waterside Station, New York Edison Company.

Johns-Manville Asbesto-Metallic Brake Blocks and Clutch Facings are designed for the most severe brake and friction conditions on any type of machinery.

Johns-Manville Pipe Insulations

The high and lasting heat insulation efficiency of Johns-Manville Asbesto-Sponge Felted Insulation is due to the fact that it confines more "dead air" spaces than any other "covering." It is made of many layers of thin felts composed of asbestos fibre and particles of finely ground sponge —built up like a book, in laminated form, with thousands of tiny "dead air" cells in every layer and a thin film of air between each layer.

Johns-Manville Asbesto-Sponge Felted Insulation, on account of the manner in which asbestos as a base is combined with other insulating materials, is practically indestructible. Unlike coverings of the moulded type, it will not crack, break or lose its insulating efficiency, and cannot be crushed by the hardest usage. It can be taken off and replaced any number of times without injury and its efficiency is as high at the end of ten years as when the insulation was first applied.

We can also supply Johns-Manville Asbestocel Pipe Insulation for pipes conveying steam at medium or low pressures or for pipes conveying hot water.

Johns-Manville Electrical Supplies

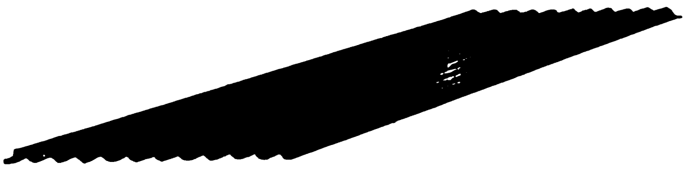
"Noark" Service Boxes;
"Noark" Subway Boxes;
"Noark" Transformer Boxes;
"Noark" Fuses;
"Noark" Service and Meter Devices;
Line Materials;
Fibre Conduit;
Fireproof Wood;
Friction Tapes.

KEASBEY & MATTISON COMPANY

AMBLER, PENNA.

BRANCH OFFICES IN THE LARGER CITIES

Asbestos Corrugated Sheathing



Used for roofing or siding elevators, rolling mills, train sheds, warehouses, breakers, tipples, or any kind of building where a PERMANENT roof is desired.

Will not rust or decay. Indestructible. Never requires paint.

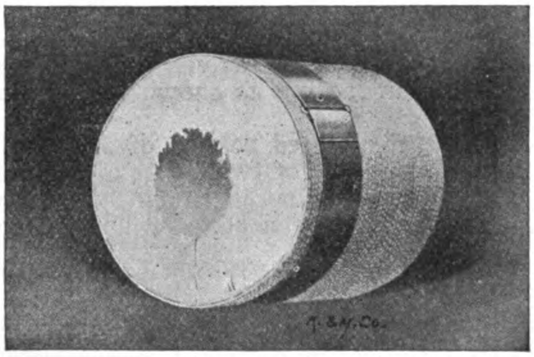
Made in sheets 27½" wide—in lengths from 4 to 10 feet, inclusive.

Applied directly on wood or steel purlins.

Composed of Portland Cement and Asbestos Fibre, mixed in the presence of a large volume of water and subjected to tremendous hydraulic pressure, this material, like all other concrete products, IMPROVES with age.

It is comparatively light in weight, from 2.8 to 3 lbs. to the square foot, and as a substitute for galvanized iron roofing or siding is unequalled.

85% Magnesia Covering



We are the original manufacturers of 85% Magnesia Pipe Coverings—the standard insulation for over 35 years—used by practically all the largest steam users in the country.

Furnished in 3-foot sections from 1" to 3" thick, to fit standard pipes ½" to 10" in diameter. For larger surfaces we supply curved segments or blocks, tape, canvas and clips.

Sectional Covering finished with a canvas jacket and metal bands. Ells, tees, valves, etc., to match.

Can also supply other pipe and boiler coverings, suitable for all requirements.

Also Asbestos and Magnesia Cements.

K. & M. Wire Inserted Sheet Packing

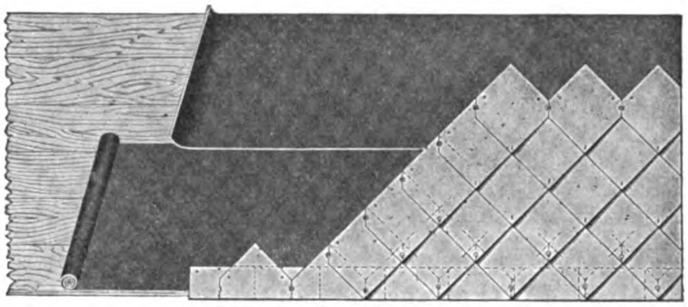
Made from pure asbestos fibre interwoven with brass wire and specially treated.

A high grade packing and suitable for many requirements.

Artificial Roofing Slates
(Asbestos "Century" Shingles)

THE EVERLASTING ROOF. This material, like the Asbestos Corrugated Sheathing, is composed of Portland Cement and Asbestos Fibre, combined in practically the same manner, but made in flat sheets from which the shingle shapes are cut.

Owing to its concrete nature, it improves instead of deteriorating with age, and roofs applied when the material was first manufactured (about nineteen years ago) are as good today as when first put on. Various tests made on this material, by both public and private testing laboratories, tend to show that it is practically everlasting.



French or Diagonal Method of Application Showing Starting Courses at the Eaves.

These shingles have been used in the United States for about nine years, and during that time approximately 50,000 different buildings have been covered with them.

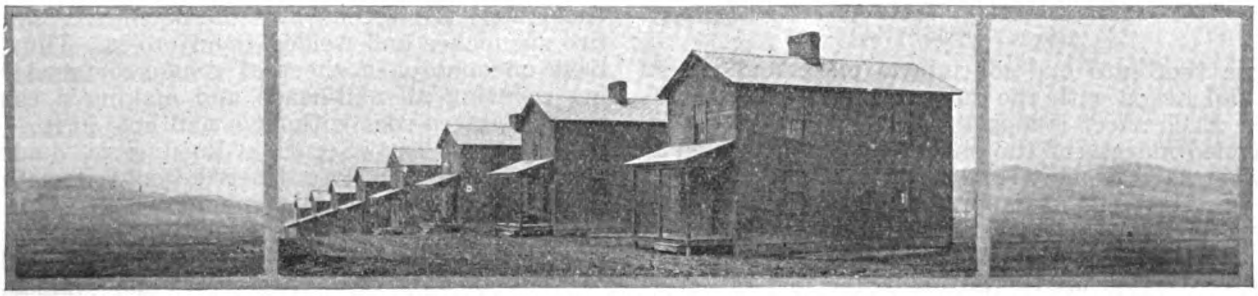
When applied according to the French Method, illustrated above, they weigh about the same as wooden shingles per square, and very much less than natural slate.

Asbestos "Century" Shingles are admirably adapted for siding, as they do not require paint and the upkeep expense of a building thus treated is therefore reduced to a minimum.

Carried in three colors—Newport Grey, Indian Red and Blue-black.

Also

Asbestos Papers and Millboards.
Asbestos Cloth Packings of all kinds.
Asbestos Brake Lining.
Asbestos Gaskets of all kinds.
Asbestos Wick and Rope.
Asbestos Twine, Thread and Cord.
Asbestos Cloth of all kinds.
Asbestos Roofings.
Asbestos Furnace Cements.
Etc., Etc., Etc.



Miners' Cottages Roofed With Asbestos "Century" Shingles That Are Fireproof.

THE NATIONAL ROOFING CO.

Factories and General Offices

166 Filmore Ave., Tonawanda, N Y.

Owning and Operating
THE NATROCO PAINT & VARNISH WORKS

District Sales Offices

Baltimore, Md., 546 Monument St., East.
Binghamton, N. Y.......91 State Street
Buffalo, N. Y..............51 Broadway
Chicago, Ill............1400 Fisher Bldg.
Cleveland, Ohio....6318 Kinsman Road
Des Moines, Ia........3rd & Market Sts.
Detroit, Mich........395 Michigan Ave.
Louisville, Ky..........314 W. Main St.
Milwaukee, Wis.............219 8th St.
New Orleans, La...........819 Julia St.
Philadelphia, Pa.....33rd & Master Sts.
Pittsburgh, Pa....607 Publication Bldg.
Providence, R. I...........830 Eddy St.
Syracuse, N. Y......569 So. Clinton St.

Manufacturers of

Asphalt Roofings and High Grade Paints

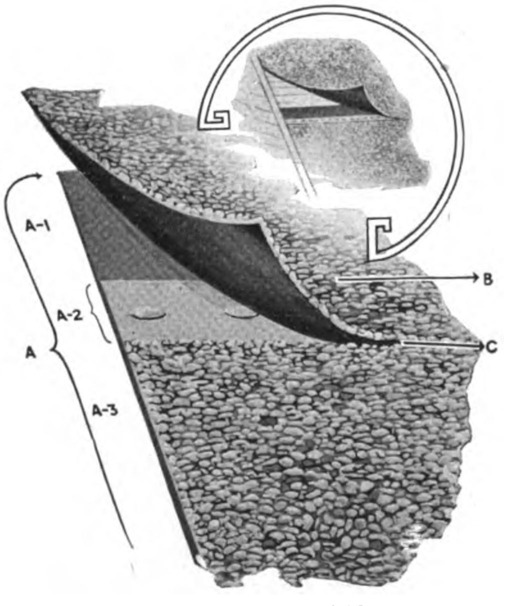
Roofing Products.

PREPARED ASPHALT ROOFINGS surfaced with Gravel, Crushed Red and Green Slate, and Fine Feldspar Rock, including SECURITY WIDE-WELD, SPARKLOID AND NATROCO ASPHALT ROOFING; NATROCO ASPHALT SHINGLES; NATROCO WALL BOARD.

Also, TRIUMPH, JEFFERSON and CHAMPION RUBBER ROOFING; NATIONAL ASPHALT FELT; "FIXIT;" MINERAL ASPHALT and NATIONAL LIQUID ASPHALT CEMENTS; NATIONAL and UNION ROOFING CEMENTS. **(For special Paints and Roof Coatings see our name in General Index.)**

Security Wide-Weld Asphalt Roofing.

Security Wide-Weld Roofing is made with a patented 6-inch joint that cannot leak, welds the whole roof into one continuous piece and covers all nail heads with the full thickness of the roofing. Each sheet is lapped over the 6-inch ungraveled margin of the sheet below and welded to it with hard asphalt cement.



6-Inch Cement Weld.

Our Roofings are approved by the National Board of Fire Underwriters.

HOW THE CEMENT WELD IS MADE—In the illustration above the indication of the lettering is as follows:

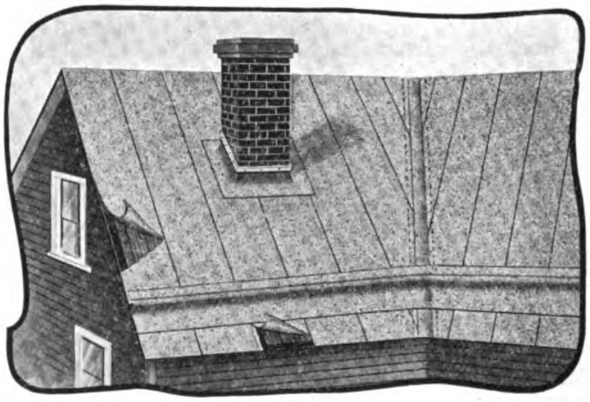
A—Upper portion of sheet of Security Roofing lying on the roof.

B—Lower portion of sheet lying next above on the roof, turned back to show ungraveled margin of sheet "A".

A-1—Bottom layer of lower sheet of asphalt-saturated felt, 36 inches wide, extending four inches beyond other layers, and along the upper edge or margin of the entire sheet or roll of roofing.

A-2—Full thickness of two layers of felt and two of natural mineral asphalt, 32 inches wide, extending two inches beyond the surfacing, and covered with tissue-paper tape to prevent sticking in the roll. The nails are driven through this full thickness of the roofing as shown in the illustration.

A-3—Gravel-surfaced portion of sheet "A", 30 inches wide, composed of two layers of asphalt-saturated felt, two of mineral asphalt, one of white sea gravel (red or green slate or fine feldspar if preferred).



In applying, the roofing "A-1" and "A-2" are covered with a thick layer of hard asphalt cement (hot) and "B" is then brought down over the entire six inches and welded firmly to it. Thus you have one unbroken sheet of gravel-surfaced roofing covering all nail-heads and making a continuous one-piece roof without a nail hole in it.

No Coal Tar—Security Roofing is made of special high-grade, long fibered wool-felt, saturated with natural mineral asphalt, which we refine by our own formula, the result of over twenty-five years' experience. Not a particle of coal-tar or pitch in any form, enters into the composition of any of our roofings.

Surfacing—The surfacing of Security Roofing is a heavy layer of natural mineral asphalt cement, in which is permanently imbedded a fine layer of white sea gravel, crushed slate or crushed feldspar rock. This adds to the durability, weatherproofing and fire-resisting qualities, and obviates all need of painting and repairs. It can, however, be changed in color by using our "Asphaltus" Coating.

Security Wide Lap Asphalt Strip Shingle

Saves 50% of the initial cost of material and labor of applying individual shingles yet retaining the same length of service with a more artistic appearance because all shadow lines are brought out in full relief.

An entirely new method of distributing surfacing on roll roofing in order to give it the appearance of Asphalt Shingles or Inlaid Slate, and at the same time double the amount of wearing possibilities.

Security Wide Lap Asphalt Strip Shingle is so constructed that upon application all chances of wrinkles or buckles are eliminated; two thicknesses of felt throughout the roofing; all nails covered by one full thickness of roofing; cements itself together at the joints for eight inches; has no raw edges.

Security Wide Lap Asphalt Strip Shingle is strong where other Shingle Strips are weak. It is a built-up Asphalt Strip Shingle adapted for a permanent and artistic roofing upon all classes of buildings where the pitch is ¼ or more.

Write for descriptive catalog.

Other Brands.

Sparkloid Asphalt Roofing is made in three weights, surfaced with crushed feldspar, finished on lower side with protective layer of flake mica; fire, acid, gas and steam proof from the bottom as well as the top. Natroco Roofing is made in four styles, surfaced with red and green slate and fine feldspar rock, having a three-inch instead of the customary two-inch joint. Descriptive booklets pertaining to all brands of Roofing sent upon request.

PAINT PRODUCTS

Ready Mixed Paints:—"Natroco" "Corporation", "Egyptian" "Natroco Interior Hard Drying Floor Paint"; "Natroco Porch Floor & Deck Paint"; "Natroco (Washable) Flat Wall Finish"; "National Creosote Shingle Stain."

Cement Paints:—"Phlorkote"; "Stuckote."

Waterproofings:—"Hydrolox"; "Retaw Proofing"; "National Bondkote"; "Minrubite Proofing."

Heat Resisting Paints:—"Protec Stac"; "Hytest."

Structural Iron Paints:—"N. R. C. Protective Paint;" "National Double X Graphite"; "Black Knight Paint."

Roof Coationgs:—"Toka"; "Asphaltus";" National Asbestos Fibrekote".

Interior Factory Paints:—"Factrolite"; "Kalsolite."

Varnishes:—"Luxall"; "Natroco Floor Varnish"; "Natroco Interior Varnish"; "Natroco Exterior Spar Varnish"; "National Asphalt Varnish."

"Natroco Ready-Mixed Paint."

A high-grade paint for use upon exterior or interior of residences, buildings, etc. Prepared from white lead, zinc oxide, pure linseed oil and turpentine japan dryer. Made in thirty-five attractive and durable colors.

"Natroco (Washable) Flat Wall Finish".

A durable and artistic mode of wall covering to be used for interior decoration. The soft tones of "Natroco Flat Wall Finish" are restful to the eyes, and harmonize with any scheme of decoration. An oil paint prepared from a specially treated linseed oil and non-poisonous pigments free from lead. Made in eighteen colors.

"Corporation Ready-Mixed Paint."

A medium priced paint of dependable quality. Prepared from sublimed white lead, zinc oxide, indestructible finely ground asbestos and a specially prepared linseed oil vehicle. Adapted for all general painting work such as residences, buildings, marine work, etc. Made in twenty-seven durable colors.

"Egyptian Ready-Mixed Paint."

A low-priced, satisfactory paint for general rough work such as the painting of cottages, barns, structural iron, metal roofs, etc. This paint is extremely resistant to the action of sulphurous gases and will outlast strictly pure linseed oil paint where subjected to the action of chemical fumes. Made in seven durable colors.

"Asphaltus Roof Coating."

For renewing, preserving and beautifying felt, rubber and other composition roofing. Made from pure natural mineral asphalt, which reinforces and protects the weather surface. "Asphaltus" is in a class by itself. Made in colors: Black, Red, Green, Brown and Terra Cotta.

"National Asbestos Fibrekote."

A combination of asphalt and asbestos fibre reduced to a consistency that will permit of application with an ordinary three knot roof brush. For use upon metal, concrete or composition roofing, etc. Especially adapted for use upon badly rusted iron roofs; fills up the holes and prevents further deterioration. Highly resistant to the action of chemical fumes. Made in Black only.

"Protec Stac."

Made expressly for the protection of heated metal surfaces such as smokestacks, boiler fronts, steam jacketed kettles, etc. Highly resistant to the action of acids and alkalies. Produced only from high melting mineral asphalts and contains no coal tar. Made in Black only.

"Black Knight (Acid Proof) Paint."

An economical "fool proof" black paint requiring no stirring or reduction before use. Adheres perfectly to galvanized iron. Can be used for painting of structural iron surfaces for the protection of same against the action of chemical fumes. Highly recommended for use upon metal roofs.

"Kalsolite."

A cold water paint in powder form. The addition of cold or warm water will prepare it for immediate use. Produces a flat white, marble-like surface that will not flake or rub off. It is fire-retarding and will not burn when subjected to direct flame. Recommended for use upon the interiors of mills, factories, stables, dairies, etc.

Special Notice:—

Descriptive literature and color cards relative to products mentioned herein will be mailed upon request. We solicit correspondence upon special paint products.

THE ALADDIN COMPANY

General Offices
BAY CITY, MICHIGAN
Mills and Distributing Points in
MICHIGAN, FLORIDA, LOUISIANA, OREGON.
Manufacturers of
Aladdin Readi-Cut House

Aladdin Houses or the Aladdin Readi-Cut System of construction are by no means new or impracticable. This method of erecting houses has been in successful operation for the past twelve years. An Aladdin house is identical in construction, design and sizes of material to the very highest type of frame construction erected anywhere. The method only differs—method of preparing the materials. Every piece of material is cut to fit by machinery in the mill, marked and numbered, ready for erection and nailing in place when it reaches the job. This permits standardization of parts, elimination of the usual 18% waste and the substitution of machine for hand labor. As regularly listed and priced in our catalog, an Aladdin house includes all lumber, millwork, hardware, plaster, paints, nails, etc., above the foundation.

CORPORATIONS HAVING PURCHASED AND ERECTED ALADDIN READI-CUT HOMES
(In quantities up to 50)

A. J. Julliard & Co.
Acme Cement & Stone Co.
Aetna Chemical Co.
Aetna Explosives Co.
Alan Wood, Iron & Steel Co.
American Zinc & Chemical Co.
Atlantic Elevator Co.
Atlantic Mills, Inc.
Atlas Powder Co.
Bristol Brass Co.
Barnes King Dev. Co.
Bay City Homebuilders Co.
Blue Mountain Mining Co.
Bridgeport Homes Co.
British Government
Buchanan River Coal Co.
Calumet and Hecla Mining Co.
Casparis Stone Co.
Climax Coal Co.
Coale Co., Wm. L.
Consolidation Coal Co.
Cuyahoga Shale Brick Co.
Central Land Co.
Cochran Coal Co.
Coghlin & Gray
Corry Development Co., The
Cudahy Refining Co.
Dominion Coal Co.
Dow Chemical Co.
Dupont Powder Co.
Ellsworth Colliers Co.
Federal Fruit & Cold Storage Co.
First Nat'l Bank of San Jacinto
Ford Co., J. B.
Forest Hill Elevator Co.
Frick & Son
Ford Collieries Co.
Goodwin-Gallagher Sand & Gravel Corp.
G G G Metal Stamping Co.
Galloway Co., Wm.
General Refractories Co.
Golden Fairview Brick Clay Co.
Gratiot Coal & Lumber Co.
Haverhill Cement Stone Co.
Hazelton Oil Co.
Helmar Coal Mining Co.
H. E. Bell & W. G. Zoller
H. L. Barber & Co.
Hercules Powder Co.
Investment Realty Co.
International Powder Co.
Interstate Water Co.
Irondequit Coal & Supply Co.
Kelleys Creek Colliery Co.
Kent Mfg. Co., The
Littlefield Realty Co.
Lukens Iron & Steel Co.
La Belle Coke Co.
Louisville Coal & Coke Co.
Lowe-Moor Iron Co.
Mass. Con. Mining Co., The
Meyers-Crump Stone Co.
Monarch Coal Co.
M. A. Hanna Mining Co.
Manhasset Mfg. Co.
Manufacturers Gas Co.
Mark Mfg. Co.
Moshannon Collieries Co.
Mt. Vernon Ladies' Association of the Union.
National Acme Mfg. Co.
National Vaccine & Anti Toxin Institute
Oneida Community Co.
Pearl Ridge Realty Co.
Potter Gas Co.
Potter Coal & Coke Co.
Postal Hotel Co.
Pennsylvania Coal & Coke Corp.
Pennsylvania Railroad Co.
Pere Marquette Railroad Co.
Pittsburg Plate Glass Co.
Rich Creek Coal Co.
Robinson Construction Co.
Rattlesnake Jack Mine
Solvay Process Co.
State of Michigan
Sheboygan Valley Land & Lime Co.
Standard Oil Co.
Standard Silk Co.
The Tide Water Pipe Co., Ltd.
Thompson Connellsville Coke Co.
Tropical Plantation Co.
Tonapah Placers Co.
Union Powder Corp.
United States Government
United States Aluminum Co.
Valley Mould & Iron Co.
Warren Axe & Tool Co.
Western New York Water Co.
Willis Coal & Mining Co.
Wisconsin Zinc Co.
Wyoming Sand & Stone Co.

Do Aladdin customers come back to us for more houses? Here's the evidence.

One of the above customers placed the following quantity orders for Aladdin Houses at intervals of from two weeks to eight weeks apart covering a period of a single year.

Sixty Aladdin Houses.
Forty Aladdin Houses.
Fifty Aladdin Houses.
Thirty-one Aladdin Houses.
Sixty-one Aladdin Houses.
Sixty-seven Aladdin Houses.
Twenty-six Aladdin Houses.
Six Aladdin Houses.
Two Aladdin Houses
Twelve Aladdin Houses.

Can stronger evidence be given than that a great modern business house shall time after time buy and erect Aladdin Houses in large numbers? Doesn't it prove effectively that Aladdin Prices, Aladdin Quality and Aladdin Service are supreme?

Quick, Economical Erection

To ship the complete material in a single car for one, two or three houses, and to have it all on the ground at one time is a tremendous advantage. It eliminates all delay incident to purchase of the many items entering the construction. It insures quantity prices on every item from the joists to the varnish. It evades the executive time-wasting of following up slow deliveries, checking deliveries, prices and quantities from many different sources and it insures the quickest possible consummation of the entire project. Back of each shipment is our qualified agreement of **sufficient material for the completion of each house.**

A group of Aladdin Houses recently erected for Bell & Zoller Mining Company, at Ziegler, Illinois.

STANDARDIZATION OF PARTS AND SUBSTITUTION OF MACHINE FOR HAND LABOR ARE THE TWO BASIC PRINCIPLES OF THE ALADDIN SYSTEM OF CONSTRUCTION.

These principles have been successfully operating for over ten years in building the Aladdin business. Over 50,000 people are now occupying Aladdin houses in the United States, England, France, Alaska, many parts of Central and South America, and South Africa.

STANDARD ALADDIN DESIGNS FROM STANDARD MATERIALS HAVE BEEN FURNISHED FOR ALL OF THE FOLLOWING TYPES OF BUILDINGS:

Houses, one and two story, all sizes and prices.

Barns; Garages; Dormitories; Guard Houses; Dining Halls; Bath Houses; Hotels; Office Buildings; Commissaries; Store Buildings; Schools; Churches; Railway Stations; Section Houses; Flag Stations; Dance Halls and Pavilions; Public Rest Rooms.

Model Miner's Cottage at Panama Pacific Exposition

The Aladdin Company received highest award at the Panama Pacific International Exposition and the Michigan Agricultural Exposition. The Panama Pacific Medal was issued upon the Model Miner's Cottage which Aladdin produced and erected for Uncle Sam. Copies of the plans of the Model Miner's Cottage are on file and available to those interested.

Highest Award Panama Pacific International Exposition.

A group of Aladdin Houses recently erected for the Dupont Powder Company. Over 300 Aladdin Houses were erected by this company in a period of six months.

DIAMOND CONSTRUCTION CO.

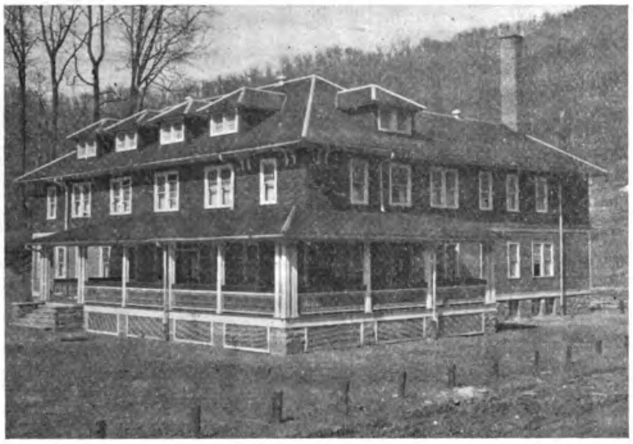
Office

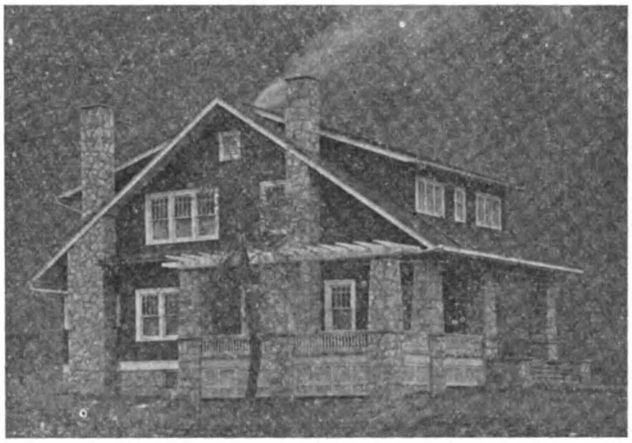
HUNTINGTON, W. VA, U. S. A.

Building Contractors and Engineers

The Diamond Construction Company are Specialists in the Construction of Mine Dwellings, and Wholesale Dealers in Lumber and Building Materials.

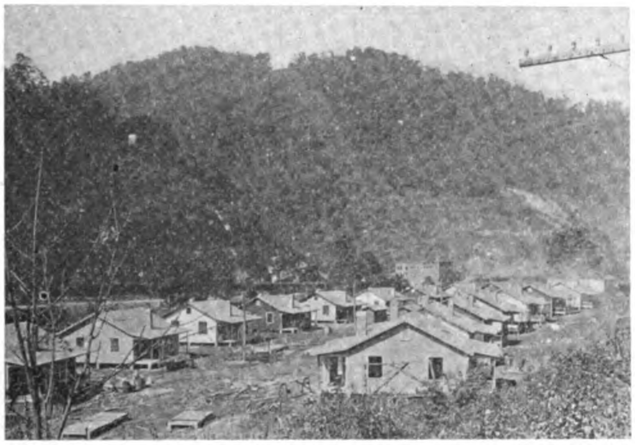
Our organization and Experience is such that seven out of the fourteen largest operating companies in the state of West Virginia and in Eastern Kentucky are continuing to avail themselves of our services after several years acquaintance with our methods. The illustrations are photographs of some of our work.

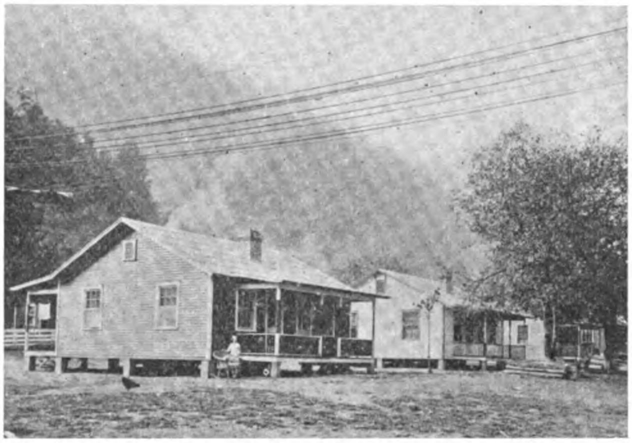




Illustrating our typical work of the better class. The illustration on the left is a club-house, constructed for a coal company.

The illustration on the right is a representative general managers house.





Illustrating some miners houses of our construction. The illustration on the left is a view of the town under construction.

The illustration on the right is nearer view of two of our houses built for a mining company.

HUNTINGTON LUMBER & SUPPLY CO.

HUNGTINGTON, WEST VIRGINIA

Minter Homes

Designed by

L. BRANDT, PITTSBURGH, PA.
Industrial House Engineer

Minter Homes
are the product of a plant operated exclusively for the manufacture of houses. You can buy Minter Homes manufactured to the farthest possible point of completion known heretofore.

Minter Homes will be erected for you ready for occupancy. Our method is different from any used heretofore in houses manufactured or built. Our system is not a complicated one. Each part of the house is plainly marked. The workmen can identify each part or piece and put it in its location without the necessity of consulting long material schedules and searching through complicated plans.

Special Features
Minter Homes are furnished in a great variety of sizes and designs, or your own ideas and plans can be used in your housing requirements.

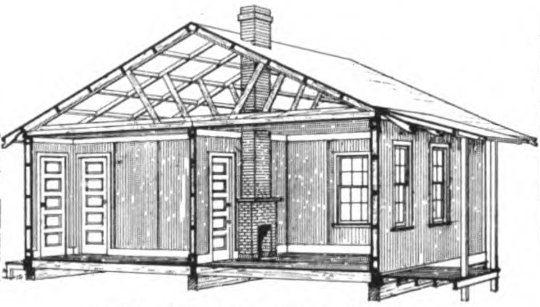
Six-Room Minter Home, Stuccoed Exterior.

Mine Housing Problems Solved

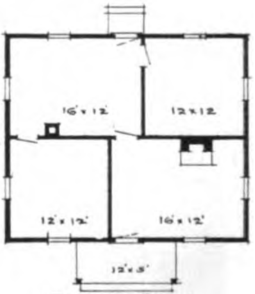
We have secured the services of Mr. L. Brandt as Consulting House Engineer. Mr. Brandt has the reputation of having designed and built more industrial houses than any other man in the country. We are now offering his latest development in housing for mining villages.

Perspective View.

Four-Room, Ready-Built.



Typical Section, Ready-Built.



Four-Room House.

It is known as the Ready-Built type.

It is built entirely in a shop.

It is designed in two or more rooms of one story height.

It is not a flimsy portable structure.

When set up and bolted together it is the most rigid and substantial house that can be built of wood.

It has an exterior of pleasing and attractive appearance.

It is weathertight and warm.

It always represents its full value, as it can be taken down and moved to a new location at small cost.

This is important and should be considered with the high cost of materials and labor.

It comes so complete that it can be erected and ready for occupancy in one day.

Complete houses come to you one or two in a car according to size.

Housing can be kept up with your development work.

It reduces field labor 90%.

It is the result of years experience in building thousands of houses.

It is with the knowledge of the past and present requirements that these houses have been developed to meet present day demands.

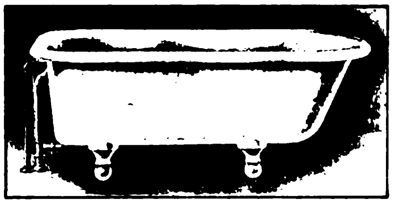
Lay your housing problems before us and without obligation to you, will furnish you plans, specifications and prices that will meet all the demands of industrial housing.

HARRIS PUMP & SUPPLY CO.

320-322 Second Ave. PITTSBURGH, PA.

Pittsburgh's Big Plumbing and Heating House

Pumps and Plumbers Supplies



Products

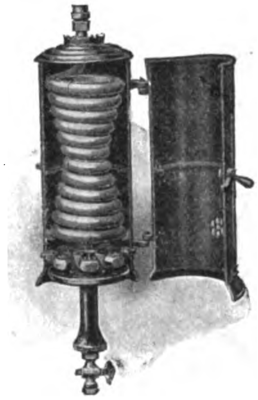
John Douglas High Grade Plumbing Fixtures, United States Sanitary Enamel Ware, Glauber's Brass Goods, Gurney Boilers and Radiators, Pipe Valves and Fittings, Range Boilers.

We can give you prompt shipments on the above from our Pittsburgh stock.

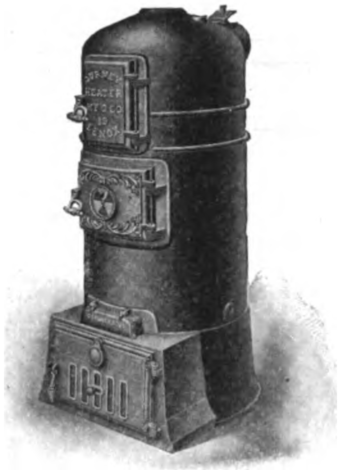
Remember this also — our Heating Engineer will help you figure on any heating obj that you may have.

See our pages 297, 576 and 790, showing

PIPE,
VALVES,
FITTINGS,
PUMPS,
ELECTRIC MOTORS,
GAS OR GASOLINE ENGINES,
WATER SUPPLY SYSTEMS.



Gurney Boilers



No. 19 Lenox Water Boiler

Made in ten sizes
Capacity 500 to 1,400 feet.

900 Series

Push Nipple Construction

Capacity for steam, 450 to 1,125 feet.

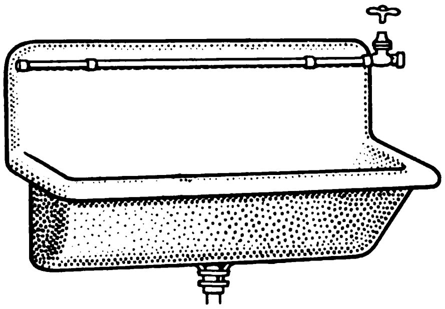
Capacity for water, 750 to 1,875 feet.

Manufactures Distributing Co.

325 PENN AVENUE, PITTSBURGH, PENNA.

SEND FOR OUR COMPLETE CATALOG OF PLUMBING FIXTURES, SOIL PIPE, ETC.

Cast Iron Porcelain Enameled Roll Rim Urinal

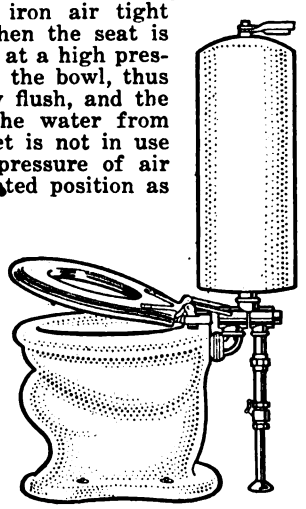


Cast Iron Porcelain Enamel Roll Rim Urinal for Public Buildings or Schools. All cast in one piece with roll rim back, no seams or crevices, easy to keep clean. Fitted with concealed wall hanger, bee hive strainer, couplings and tail piece, brass flush pipe and key stop cock as shown. Furnished in different lengths as listed below in white enamel.

	With flush pipe as illustrated.	With flush pipe all the way around.
No. 276. 85 pounds, 24 inches.....	$16.50	$28.55
No. 277. 135 pounds, 36 inches....	22.00	35.65
No. 278. 185 pounds, 48 inches....	27.50	43.75
No. 278½. 210 pounds, 60 inches..	33.00	51.35

Our Seat Action Factory Toilet

It is the most practical up-to-date factory toilet on the market. The seat is so arranged that when in use it rests down on the bowl and opens the valve and permits the water to enter the galvanized iron air tight tank compressing the air, so when the seat is released the air forces the water at a high pressure out through the outlet into the bowl, thus making a complete and sanitary flush, and the valve automatically shuts off the water from the supply line. When the toilet is not in use the tank contains the natural pressure of air only and the seat is in an elevated position as shown in illustration.



The Tank is made of heavy galvanized iron and guaranteed for fifteen years.

The Seat is golden oak without cover, with heavy hinges attached to flush valve, and fully guaranteed for five years.

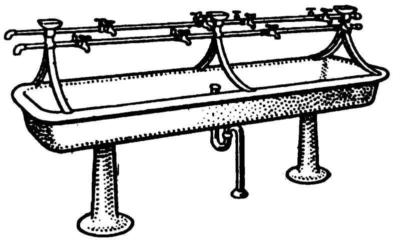
The Valve is made of solid brass heavily nickel-plated, simple in construction and positive action, and can easily be adjusted to use the desired amount of water.

The Bowl is our syphonic action wash down pattern, vitreous china, very heavy construction, free from all defects, glazed inside and outside. Shipping weight 130 lbs.

No. 666 Factory Toilet, as described. Price, $32.00.

No. 668 Factory Toilet, with jet bowl and open front seat, $34.00.

Porcelain Enameled Roll Rim Double One-Piece Factory Wash Sink



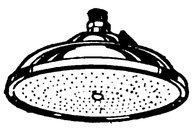
No. 524. Porcelain Enameled Roll Rim Double One-Piece Factory Wash Sink, with overflow made of heavy cast iron enameled inside, painted outside, supported on painted cast iron standards, supply pipe supports, with two galvanized iron supply pipes, one for hot and one for cold water, 1½-inch nickel-plated brass trap. ½-inch brass nickel!-plated compression faucets and galvanized iron soap cups. No factory wash room complete without this outfit. Shipping weight 200 pounds.

Width of sink, 28 inches; depth of sink, 8 inches.

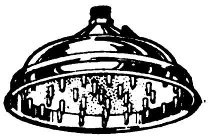
Price, 6 foot long, equipped with 12 faucets............$51.40

Price, 8 foot long, equipped with 16 faucets............ 59.15

Factory Shower Heads



No. 516.



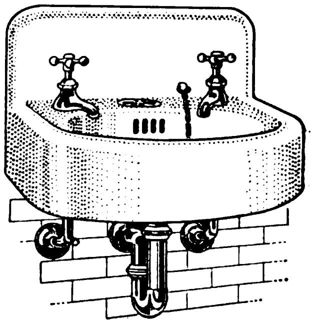
No. 517.

Here we show two of the very latest up-to-date Shower Heads. For factories or work shops they can't be beat, and are just what you have been looking for. They can be hung at any desired angle or position. They are made of solid brass highly nickel-plated with patent valve, allowing an intake of air after the water has been turned off, which completely empties the head of water, and prevents constant and lengthy dripping.

No. 516. Rain Shower is 8 inches in diameter, has flat perforated strainer, and is very good for a medium priced shower head. Price, $2.50.

No. 517. Tubular Shower Head is 8½ inches in diameter, made with brass tubes extending down from bottom about one!-half inch, which makes a very effective spray. They are both made for ½-inch pipe connection. Price, $3.00.

Porcelain Enameled Iron One!-Piece Lavatory

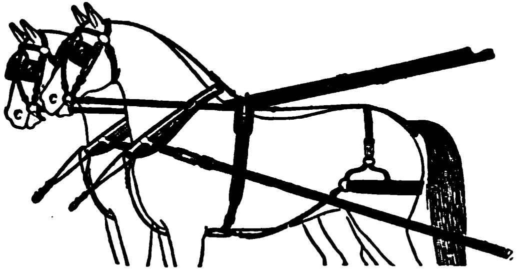


No. 116. Porcelain Enameled Iron One-Piece Half Circle Wide Apron Lavatory with wall hanger, sanitary soap tray cast in lavatory, waste plug and coupling, rubber stopper, nickel-plated chain stap and chain. two low down nickel-plated basin cocks with cross handles and china index top, one 1¼-inch nickel-plated P trap with waste to wall, and two nickel-plated supply pipes to wall. Complete, ready to set up. Size of slab, 17x19 inches; height of back, 6 inches; 10½x13½-inch patent overflow basin. Shipped from Pittsburgh. Shipping weight, 80 pounds.

Price, Lavatory without Trimmings....................$ 7.85

Price, Lavatorye with Trimmings, as described........ 14.10

WE MANUFACTURE ALL KINDS OF HARNESS AND HORSE GOODS, AND JOB A FULL AND COMPLETE LINE OF SADDLERY HARDWARE.



SEND FOR COMPLETE HARNESS AND HORSE GOODS CATALOG. WE MAKE A SPECIALTY OF COAL MINE HARNESS.

CEMENT PRODUCTS CO.

WILMINGTON, NORTH CAROLINA

BRANCH OFFICES

Oliver Building,
Pittsburgh, Pa.

328 Chestnut St.,
Philadelphia, Pa.

East Point,
Atlanta, Ga.

Union Trust Building,
Charleston, W. Va.

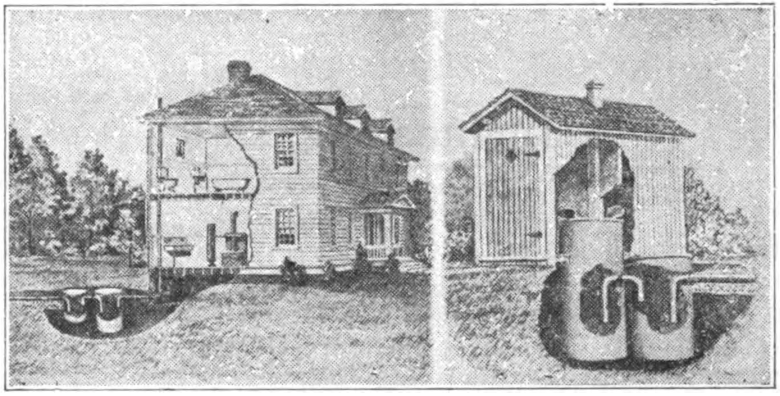
"Sanisep" Portable Sewerage Disposal Systems

(Trade Mark Reg.)

"SANISEP" Portable Sewerage Systems employ the well known L. R. S. or two-tank principle of sewerage disposal which was devised by the United States Public Health Service.

They are composed of two reinforced concrete tanks (the only vertical tanks manufactured with the bottom and side walls moulded in one piece). The tanks are carefully waterproofed to prevent seepage and are guaranteed not to leak. All scavanger work is done away with and no chemicals are required.

"SANISEP" Systems are made in several sizes for use with or without plumbing and running water. They are economical in cost, easily installed, and may be shipped anywhere under favorable freight rates.



(Patented)

No. 11—System for Average Size House with Plumbing.

No. 2—System for Two Families. No Running Water Required.

A Few of the Many Users of "Sanisep" Systems

United States Coal & Coke Co.	Gary, W. Va.
Crystal Block Mining Co.	Welch, W. Va.
Greensburg-Connellsville Coal Co.	Pittsburgh, Pa.
The Leckie Collieries Co.	Leckieville, Ky.
Quemahoning Creek Coal Co.	Somerset, Pa.
Burgettstown Coal Co.	Burgettstown, Pa.
Fairfax Mills	Fairfax, Ala.
H. C. Firck Coke Co.	Scottdale, Pa.
Williamson Coal Co.	Williamson, W. Va.
Erwin Cotton Mills Co.	Durham, N. C.
Roanoke Mills Co.	Roanoke Rapids, N. C.
Dillon Cotton Mills Co.	Dillon, S. C.
Parterdale Mills	Porterdale, Ga.
Covington Cotton Mills	Covington, Ga.

KEYSTONE

THE.
MINING
CATALOG

CONSOLIDATED PUBLISHING
COMPANY INC.

COKE OVEN SECTION

Engineering Data

Coke Oven Construction.

Coal Tar Tree

Standardization of Shapes.

The following manufacturer has catalogue descriptions in this section:

Marion Machine Foundry & Supply Co.

For additional descriptions of Ventilating Equipment not appearing in this section refer to index of Products in front of the book.

Coke Oven Data

Courtesy Harbison-Walker Refractories Co. and United Fire Brick Co.

There is a tendency to standardize rectangular oven construction, the many advantages to be derived from such a standardization being obvious.

The following dimensions may be regarded as definitely settled:

Batter of outside walls 2½" to the foot

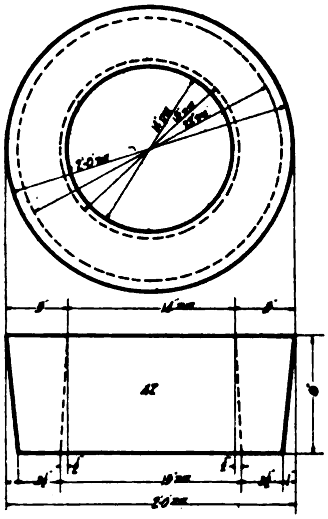
Width of door 5 feet at each end.

Ovens with doors wider at one end than the other are no longer being constructed. There is no standard for the height of the door from the bottom plate to the base of the arch, but it is possible that future ovens will be constructed by using four jambs each 9" in height, making a total height of from 36½" to 37", depending upon the size of the joints. The arch having a span of 5 feet and a rise of 18", giving a radius of 2' 10" may be regarded as definitely accepted as standard.

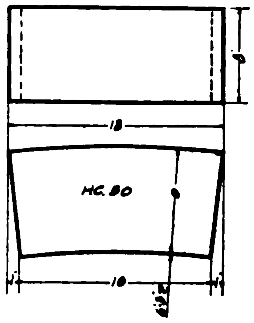
There is a tendency to standardize every fire brick and fire clay shape entering into the construction of rectangular ovens and if these tendencies are supported by those building such ovens in the future it will inevitably result in economy in construction and repairs. Every new design involves a new set of molds and when repairs are needed, instead of being shipped from stock, they have to be made up on special order. Moreover, if repairs are ordered from someone other than the manufacturer furnishing the material in the first instance, more molds would again have to be made. It is also necessary in all lines of business to charge more for material made up on special order than for standard material which can be regularly made and carried in stock.

By the co-operation of all concerned it will likely be possible in the near future for every coke oven fire brick manufacturer to carry in stock material for repairs of standard rectangular coke ovens.

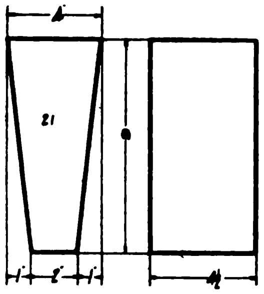
Standard Shapes and Dimensions of Coke Oven Materials



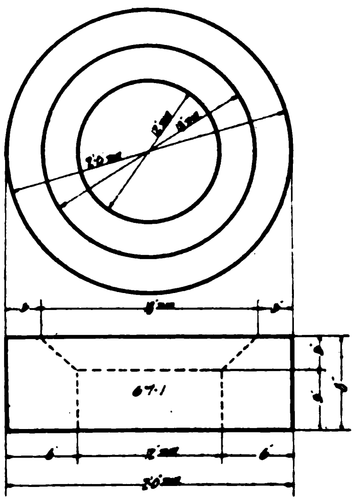
TRUNNEL HEAD



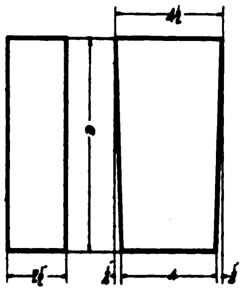
RING WALL BLOCK



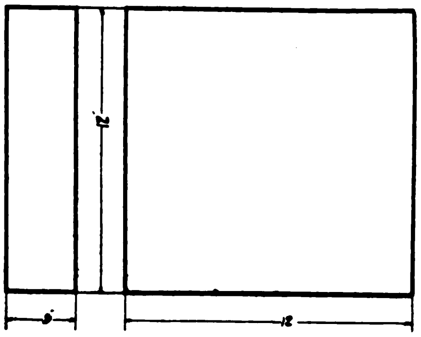
BULLHEAD



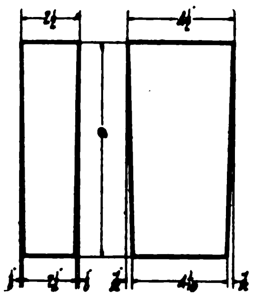
RING



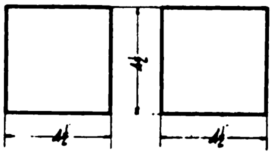
LINER



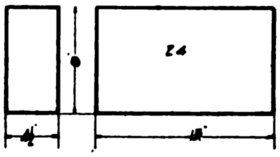
FLOOR TILE



CROWN

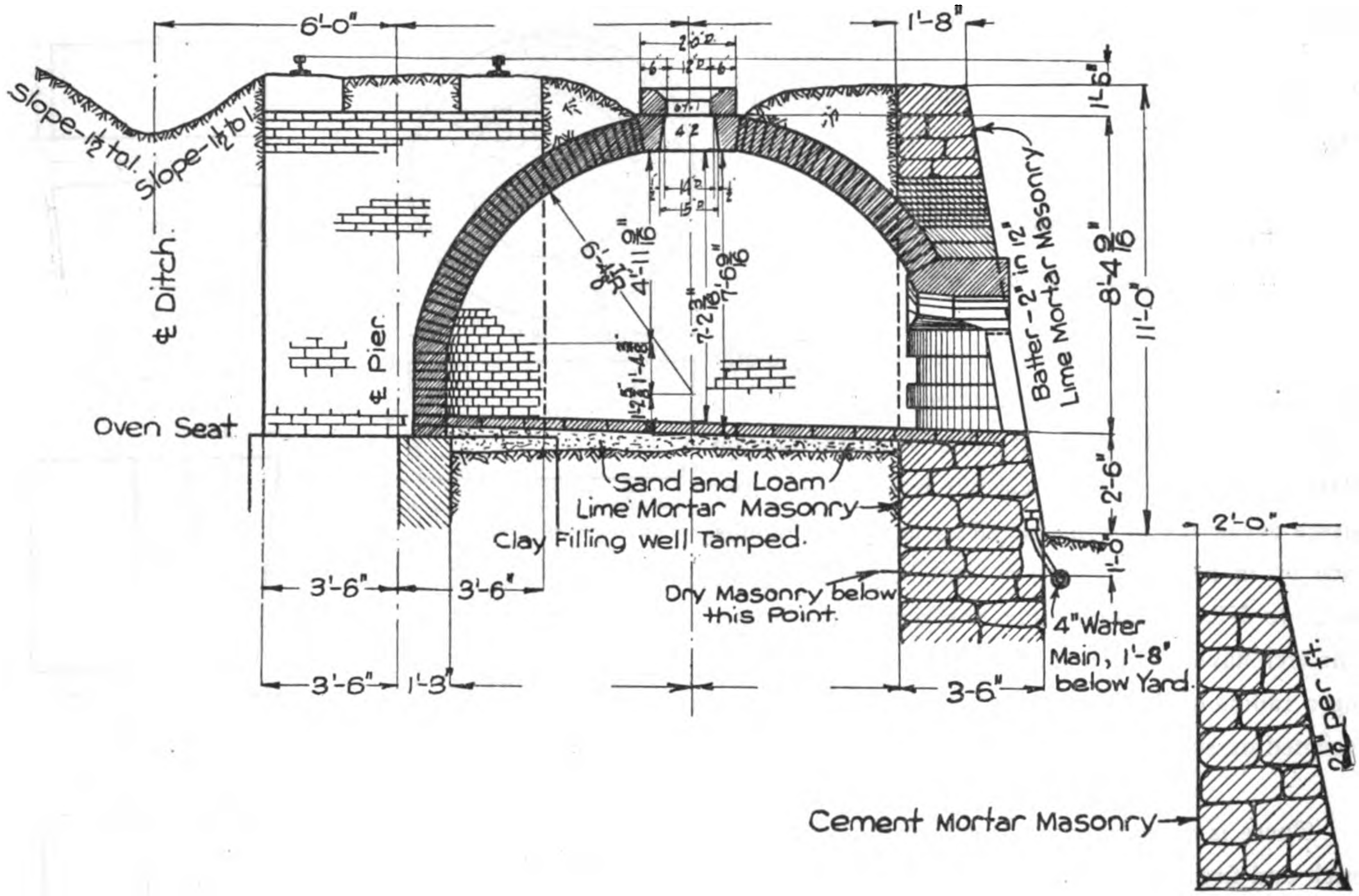


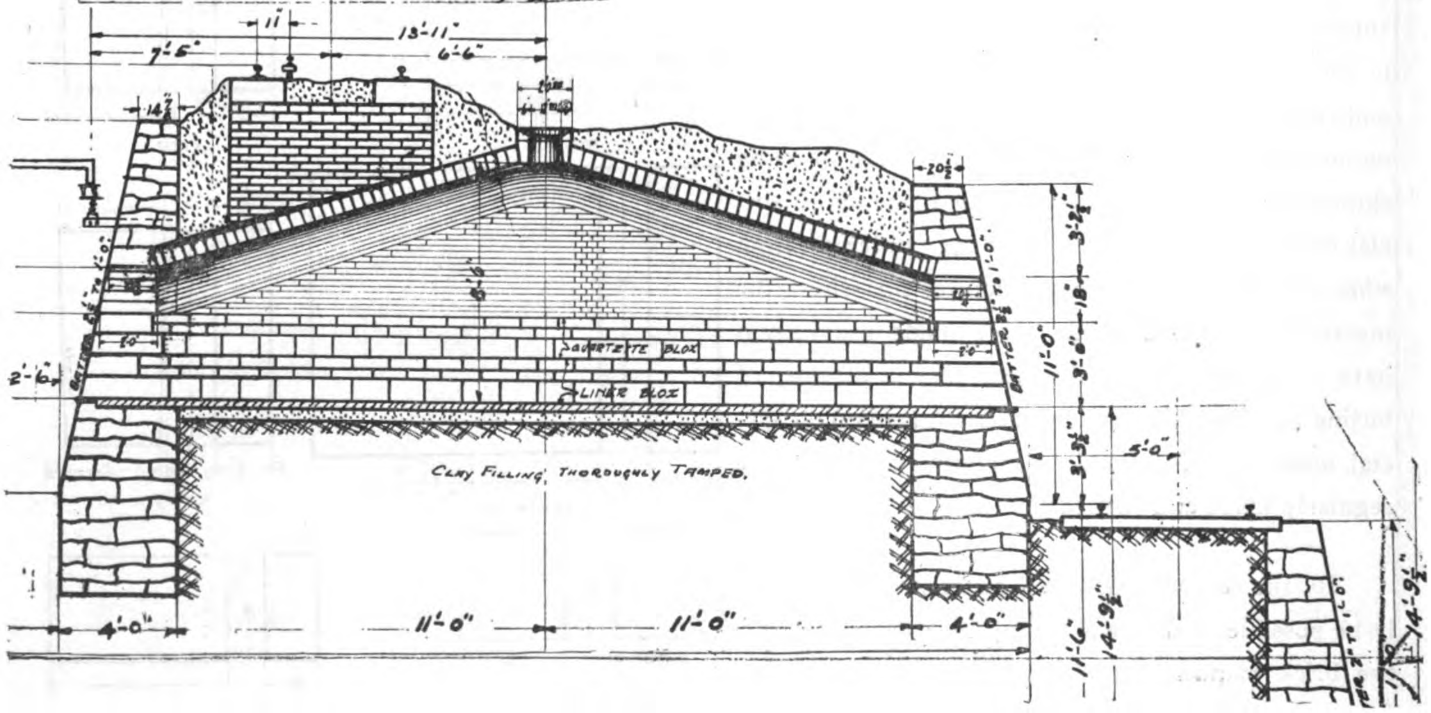
4½ x 4½ x 4½
DOOR BLOCK



LINER BLOCK

Diagrams Showing Coke Oven Construction

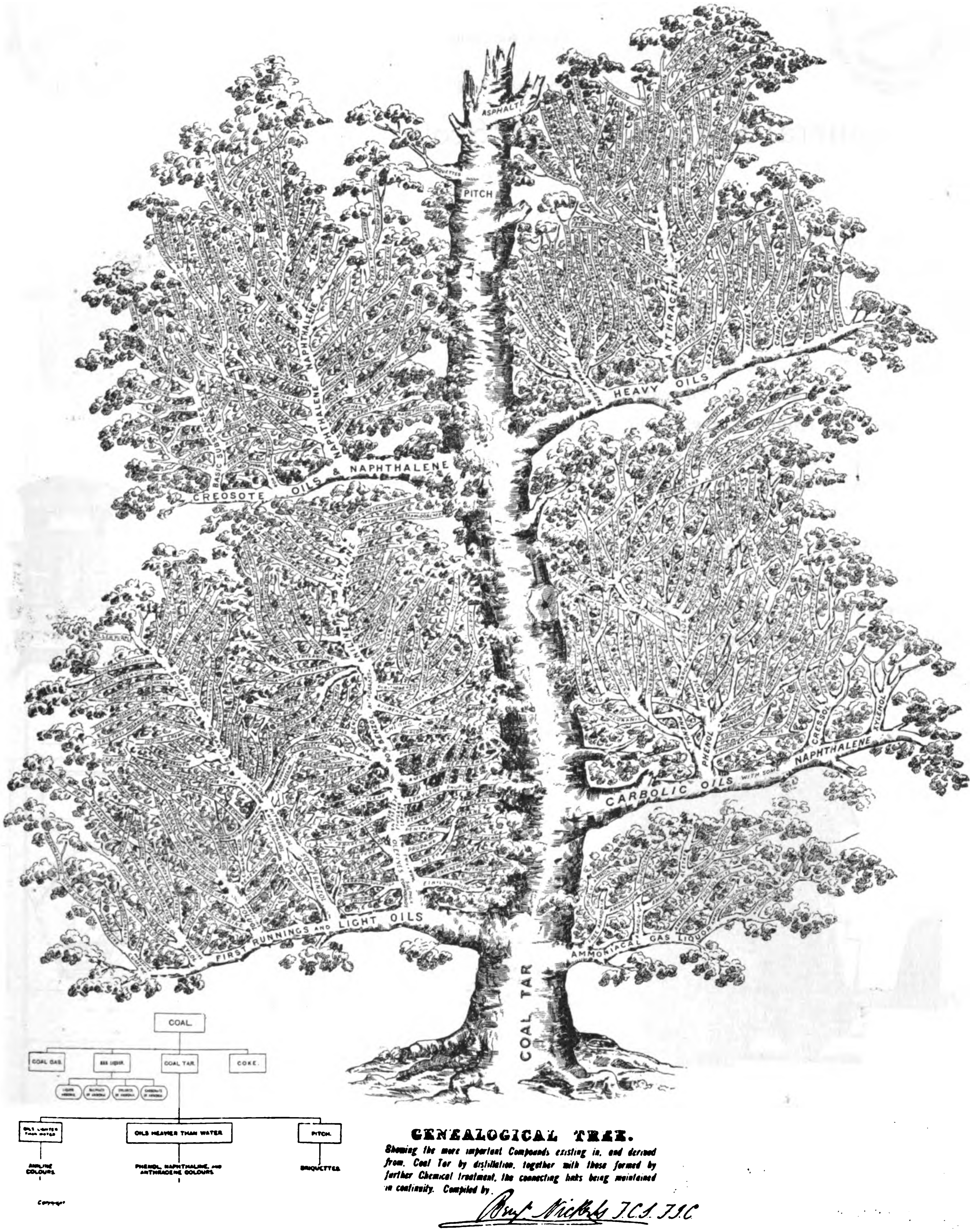




PLAN.

Courtesy Harbison-Walker Refractories Co.

Coal Tar Tree



GENEALOGICAL TREE.

Showing the more important Compounds existing in, and derived from, Coal Tar by distillation, together with those formed by further Chemical treatment, the connecting links being maintained in continuity. Compiled by

Benj. Nickels F.C.S. F.I.C.

Courtesy C-A-Wood Preserver Co.

Marion Machine, Foundry & Supply Co.

Scottdale Branch
SCOTTDALE, PENNA.

Direct Representatives
CROCKWELL MINE & MILL SUPPLY CO., St. Louis, Mo.
S. H. MEEM & CO., Bluefield, W. Va.
J. F. DONAHOO CO., Birmingham, Ala.

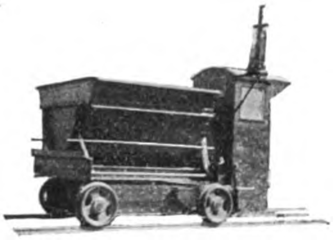
General Specification of "Scottdale" Coking Larries

Beside the "Scottdale" coking larry we have been marketing so successfully for 40 years we make special designs of electric cars for handling of rock, slate, coal, stone, ore, etc.

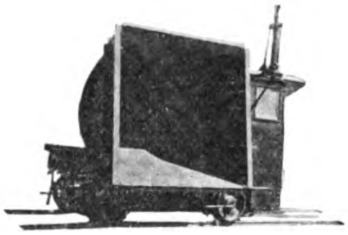
Cuts show a slate larry for handling mine refuse, built in 3 and 4 cu. yd. capacities to dump either side or in front. Car will build its own roadway, operate up a 7½ per cent grade. Track gauges vary from 42" to 4'-8½", according to capacity.

We build other designs of bodies to suit your special requirements.

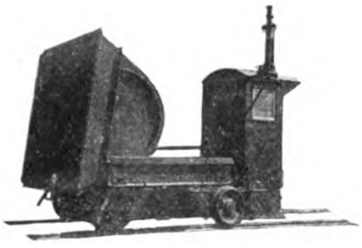
Remember we manufacture Coal Mine Surface Equipment exclusively, and it costs you nothing to get our recommendations and proposals.



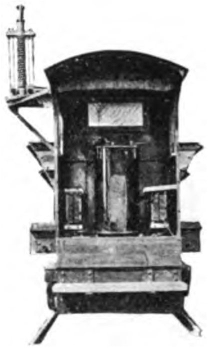
Running Position.



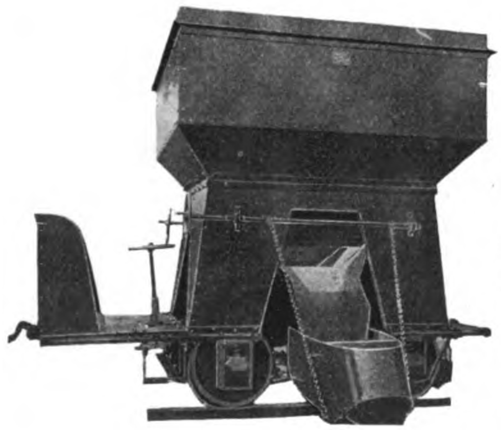
Side Dumping.

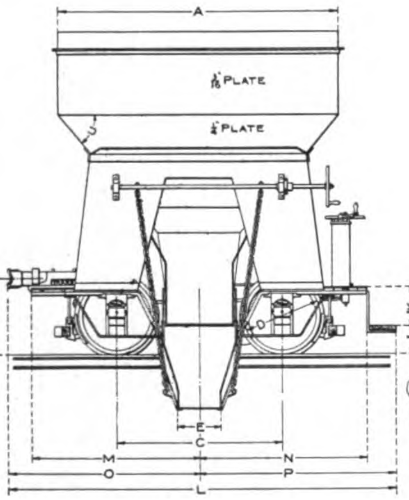


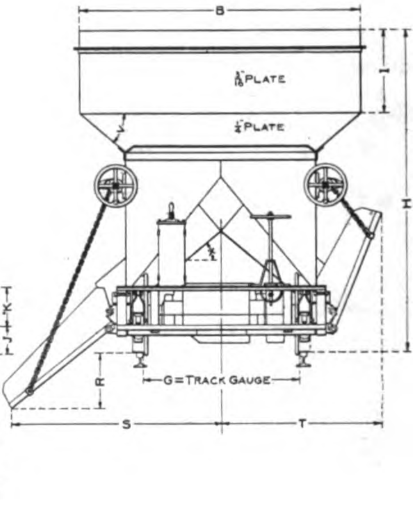
Front Dumping.



Rear View.







No. of Larry	H. P. Motor	Larry for	Capacity in cu. ft.	Weight Complete	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	R	S	T	U	V	X
					DIMENSIONS IN INCHES.																			**Degree of Angles**		
1701-25	25	Slack or Washed Coal	390	12,500	120	102	60	28	15⅝	28	56½	130	34	10¾	13¾	141	61	61	69¼	71¾	To Suit Ovens	To Suit Ovens	To Suit Ovens	49	45	40
1701-30	30	Washed Coal	390	12,600	120	102	60	28	15⅝	28	56½	130	34	10¾	13¾	141	61	61	69¼	71¾				49	45	40
220-25	25	M. R.	315	10,200	102	102	60	28	15⅝	28	56½	114	36	10¾	13¾	141	61	61	69¼	71¾				47	36	36
2208-30	30	M. R.	315	10,300	102	102	60	28	15⅝	28	56½	114	36	10¾	13¾	141	61	61	69¼	71¾				47	36	36
1924-25	25	Slack or Washed Coal	290	10,700	102	102	60	28	15⅝	28	56½	122	26	10¾	13¾	141	61	61	61¼	71¾				55	45	40
2233-25	25	Washed Coal	290	10,600	102	102	60	28	15⅝	28	56½	117	30	10¾	13¾	141	61	61	69¼	71¾				50	40	40

POWER PLANT SECTION

Treatise
and
Engineering Data

Table—Water Required per minute to Feed Boilers.

Table—Properties of Saturated Steam.

Compressed Air Transmission.

Table—H. P. Required (Single Stage Compression).

Table—H. P. Required (Two-Stage Compression).

Table—H. P. Required (Three-Stage Compression).

Table—Loss of Pressure in Compressed Air Transmission.

Table—Discharge of Air Through an Orifice.

Table—Air Required to Run Drills.

Standard Specifications for Lap-Welded Seamless Steel Boiler Tubes.

Mechanical, Electrical and Heat equivalents.

The following manufacturers have catalogue descriptions in this section:

Allis-Chalmers Mfg. Co.
American Steam Conveyor Corp.
American Steam Gauge & Valve Co.
Armstrong Cork & Insulation Co.
Ashton Valve Mfg. Co.
Ball Engine Co.
Brownell Co.
Caldwell, W. E. Co.
Cancos Mfg. Co.
Chandler & Taylor Co.
Cling Surface Co.
Combustion Engineering Corp.
Coppus Engineering & Equipment Co.
Crane Company.
Cyclone Grate Bar Co.
Dodge Sales & Engineering Co.
Durabla Mfg. Co.
Engineer Company, The.
Erie City Iron Works.
Fairbanks Co., The
Foster Engineering Co.
Freeman Mfg. Co.
Garlock Packing Co.
Gem Mfg. Co.
General Electric Co.
Goodrich, B. F., Co.
Hagan, Geo. J. Co.
Harris Pump & Supply Co.
Harrison Safety Boiler Works.
Homesteal Valve & Mfg. Co.
Houston, Stanwood & Gamble Co.
Hunter Pressed Steel Co.
Ingersoll-Rand Co.
Jenkins Bros.
Keeler, E., Co.
Kerr Turbine Co.
McClave-Brooks Co.
McCord Mfg. Co.
Moloney Electric Co.
National Valve & Mfg. Co.
New York Belting & Packing Co.
Nicholson, W. H. Co.
Northern Equipment Co.
Obermayer, S. & Co.
Peerless Rubber Mfg. Co.
Permutit Co., The
Pittsburgh Filter Mfg. Co.
Power Efficiency Corp.
Power Specialty Co.
Quaker City Rubber Co.
Renton, Wm., Inc.
Ridgway Dynamo & Engine Co.
Scaife, Wm. B. & Sons
Schaffer Eng. & Eqiupment Co.
Sims Co.
Spray Engineering Co.
Sterling Equipment & Supply Co.
Union Iron Works.
Valley Iron Works.
Walsh & Weidner Boiler Co.
Westinghouse Traction Brake Co.
Westinghouse Elec. & Mfg. Co.
Wickes Boiler Co.
Vogt, Henry Machine Co.

For additional descriptions of Power Plant Equipment not appearing in this section, refer to Index of Products in front of book.

MINE POWER PLANTS

By C. G. GRABE*

Energy for industrial purposes is available from many sources, each source having its own particular field in which it can be applied to advantage. In most industrial operations, however, it becomes necessary to use power in several different forms for accomplishing a single operation, and in no instance, in spite of present day almost perfect mechanism, is it possible to entirely dispense with the vital forces or muscular power of men and animals in completing any kind of production. This type of power, although necessary, has become so expensive and so limited in supply, that invention has brought relief in the form of hydraulic, electric, gas, steam and numerous other kinds of energy which at the present time are available for every industry in almost any quantity desired.

In considering the relation of power to coal production, however, it is obvious that in the greater percentage of cases the source of energy most economically available in quantities is that derived from the combustion of coal and the expansion of steam; therefore, this space will be devoted entirely to steam power plants, and forms of power resulting therefrom.

STEAM POWER PLANTS

For convenience steam power plants in connection with coal mining are divided into two main classes: First, small isolated plants supplying power to one or possibly two mines in the immediate vicinity, and second, large central stations located preferably at the load center and supplying a number of mines from a high voltage transmission network.

With the smaller type of plant it has been the practice to transmit the power to the workings in the form of compressed air, and low voltage electric current, and to drive immediate surface equipment such as fans, hoists, pumps, shop engines, etc., with either steam or low voltage current. Due to the low efficiencies of these methods of transmission it is evident that this type of plant must necessarily be placed comparatively near the operations, otherwise, most of the power generated will be lost.

In the second type of power systems, the central plant is placed as near the load center as the water supply and other governing factors permit, and the generated power is transmitted at a suitable high voltage to the various mines, where it is transformed and converted into proper voltages for direct use.

The latter system offers by far the less expensive method of obtaining power and not only does it cause the cost of power to drop to a very low figure, but also permits an increase in production, which, in many cases amounts to 150 or 200 per cent.

In extremely gaseous mines it is found hazardous and undesirable to use electric current because of unavoidable flashes, but even in these rare instances the advantages of the central plant system are not impossible, because the power can be transmitted in the usual manner and converted into compressed air at the surface instead of low voltage current.

The requirements of these two classes of power plants differ widely in many respects, and throughout this article, in considering the details, an attempt is made to set forth a distinction between these requirements.

Location

Local conditions have such an influence on the location of power plants that it becomes impossible to lay down a set of fixed rules which will apply to all cases. In general, however, the chief factors governing the location are, first, method of power transmission; second, adequate water supply, especially for condensing purposes; third, facility of obtaining and handling coal, and fourth, topographical and subsoil conditions.

The method of power transmission is mentioned first, for the reason that this factor decides the permissible distance that the plant can be located from the workings. Compressed air and low voltage current, as mentioned above, become a very inefficient and expensive method of transmitting power for a distance much in excess of 4,500 feet. This restriction usually makes it necessary to pump the supply water; however, these smaller plants are preferably operated non-condensing so that they may require as little as 30 pounds of water per horse-power. If the water, therefore, is to be taken from a distant source, an attempt should be made to compensate for this disadvantage by locating the plant as near the load center as permitted by topographical conditions. An effort should also be made to select a site allowing the coal to be delivered to the boiler room bunkers without unnecessary handling, for this item may amount to several hundred dollars per month.

The high voltage transmission system has no great influence on the location of the central plant. It is, of course, desirable to place the plant near the load center, but a deviation from this center causes an increase in cost which is almost proportional to the distance so that an added expenditure is, in many instances, justified by the saving resulting from locating the plant nearer the coal or water supply.

If the water supply is limited, and topographical conditions unfavorable for a storage lake or the cost of land high, a cooling tower or some artificial means of dissipating the condenser heat must be resorted to. When this becomes necessary, the coal supply and the load center of the system become the chief factors in determining the location of the plant. In choosing the site for either type of plant if the subsoil conditions are not known a test should be made to determine the reliability of the under soil to maintain the concentrated weight of the equipment. It frequently happens, by a small change in the proposed location, deep and costly foundations can be avoided.

---

*Electrical Engineer, with Randolph-Means Co., Pittsburgh, Pa.

Buildings

All power plants should be made of fireproof material throughout; in many cases no fire insurance is carried, and an oversight with respect to the building may mean the loss of the entire equipment.

The approved types of construction are:

(a) Steel structure, with brick walls, concrete floor, and concrete slate or tile roof.

(b) Steel framework, with concrete walls, floor and roof.

(c) Hollow block tile, with cement floor, steel truss roof and fireproof roofing.

(d) For the smaller temporary plants corrugated iron may be used to a limited extent.

The building should be separated from other buildings to avoid danger from fire and trouble from vibration. It should be built with at least two rooms, one for engines and generators, etc., and the other for boilers, and these rooms should be divided with a fireproof partition to keep the machines free from dirt and moisture.

If the plant is to have a capacity of 1,000 H. P. or more, the structure columns of the building should be designed with a view to carrying a crane of such a capacity as the size of the plant demands.

In localities where the price of land is high, the buildings are made with two or more stories, having the engines placed above and the boilers below, or vice versa; however, in coal mining districts the cost of ground is usually a comparatively small item, and in these cases a one-story building with brick walls, steel truss roof and cement floor is most common. If the plant is large with high pressure turbines as prime movers, the building should be constructed with a well-drained, well-lighted basement for condensers, pipes, ash hoppers and condensate traps.

General Arrangement

The boilers should be arranged in batteries of two, with sufficient space around each battery to facilitate frequent inspection, and cleaning of flues, shells and combustion chambers. Where practicable, all pumps, heaters and other accessories which require frequent attention should be located where they are readily accessible and free from excessive dirt. The engines or turbines should be placed in a room apart from the boilers and as near the boilers as practicable, so that long feeder lines and consequent loss in steam pressure can be avoided.

Boilers

The fundamental requirements for good boiler design are:

1. The materials of construction should be of the best, and have great excess of strength over any legitimate strain.

2. The water space should be divided into sections with large free passages between the different sections, and so arranged that should one section fail the destructive effects will be confined to the escape of the contents of this section only.

3. The water surface should be sufficiently large to allow the steam to disengage from the water without foaming.

4. The boiler should have sufficient capacity to prevent fluctuation in steam pressure and water level.

5. Thorough and constant circulation of water is required to maintain all parts at the same temperature, thus eliminating severe strains in the metal resulting fromu nequal expansion.

6. Relative to safety and economy, all parts should be readily accessible for inspection, cleaning and repairs, and the boiler should be equipped with the best safety valves, gauges and other fixtures.

All commercial types of boilers, when subjected to the same kind of furnace and flame conditions, give practically the same efficiency and economy in the evaporation of water. The conditions which limit the choice of type are: The space required, and the maximum rating at which they can run commercially in every-day service.

In the early periods of general use, boilers were classified as externally-fired, and internally-fired, but today the preferred classification is, fire-tube, and water-tube boilers.

Sub-dividing fire-tube boilers, we have, the cylindrical, cylindrical-flue return tubular locomotive, and vertical fire-tube; and sub-dividing water-tube boilers, we have sectional, coil, and plain water-tube types.

The distinction between fire-tube and water-tube boilers may be explained as follows:

In the fire-tube boilers, the hot gases from the furnace pass inside of the tubes which traverse the boiler shell. The water surrounds these tubes and absorbs a portion of the heat of the gases by conduction and convection. These boilers are ordinarily built in a cylindrical shape, the main outside drum embodying the whole unit and holding the contents intact.

In the return-tubular boiler, which is one type of fire-tube boilers, the hot gases pass beneath the boiler shell to the rear of the setting, at which point they enter the fire-tubes, and are discharged into the stack at the front.

Water-tube boilers differ from fire-tube in that the tubes or sections contain the water, while the furnace, gases circulate around the tubes. The heat is conveyed to water in the same manner as in the fire tube type.

The separate tubes or sections enter a common reservoir or drum at the top of the boiler, where the steam is liberated from the water surface. This type of boiler is made up with tubes set vertical or inclined at an angle, never horizontal, to facilitate the circulation of water. Some types, also, have the generating units arranged in the form of coils or spirals, the water entering at the bottom and as it becomes heated, it expands, rising to the top and discharges into the common drum at the top.

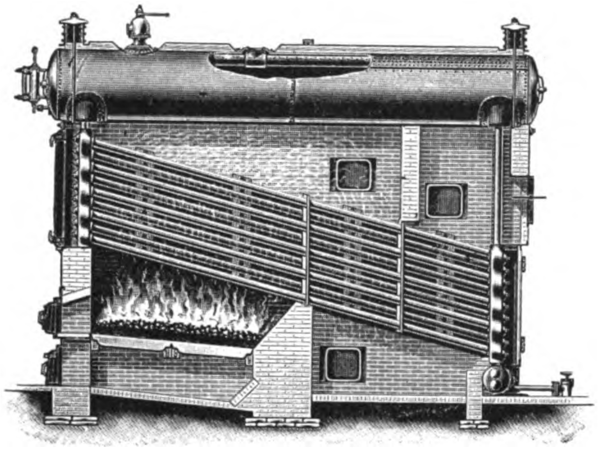
BOILERS

Water-Tube Boilers

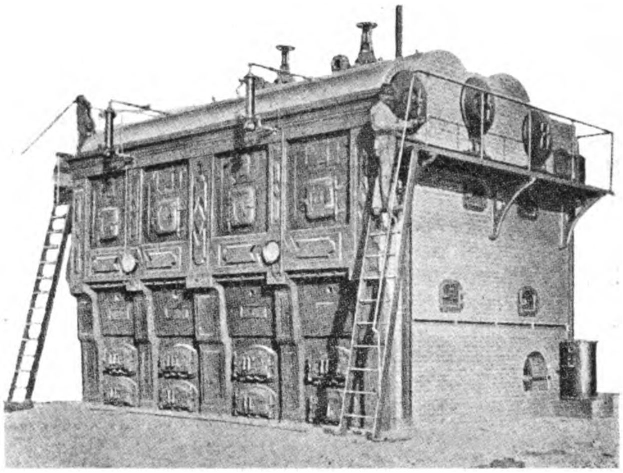
Boilers of this type built up of a number of generating vessels and so joined together that the steam from all of the separate sections is delivered to a comomn disengagement water surface, forms a unit which is very safe owing to the sub-divided sections which require no stayed surface.

These boilers are much lighter, require small floor space per unit of capacity, and have practically all of the water surface accessible either for hand cleaning or for turbine tube cleaners.

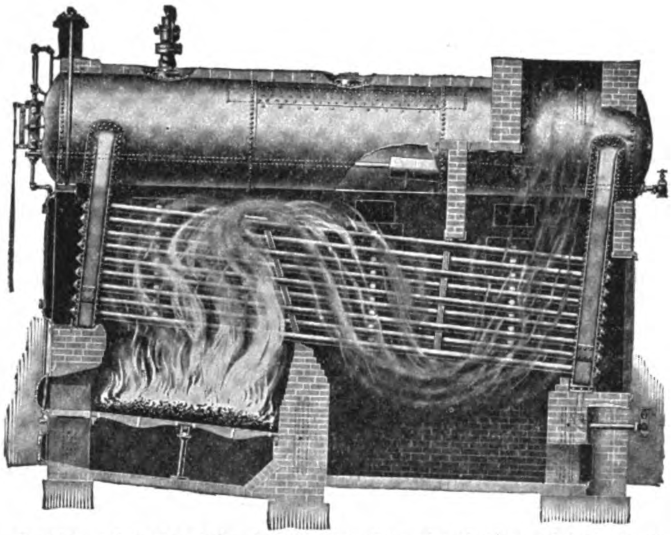
The disadvantage of water-tube boilers is the fact that the boiler must be shut down for repairs when a leak occurs in one of the tubes, whereas, in the fire-tube types the defectice tube can be plugged. There also exists a small water reserve, and small steam space. The boilers are much higher in initial cost than fire-tube boilers.



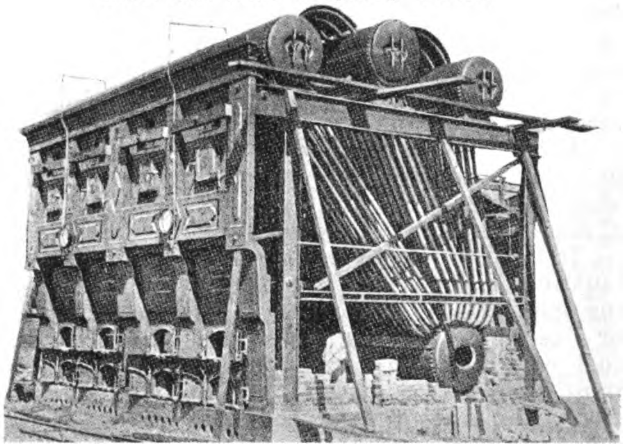
Section of water-tube boiler and setting.



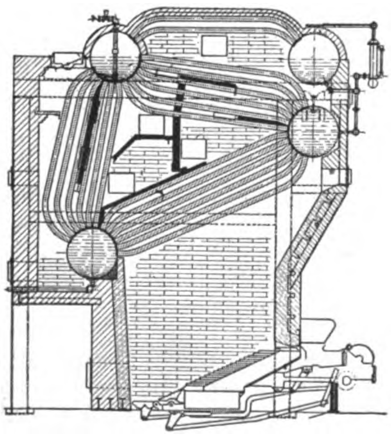
Water-tube boiler completely erected.



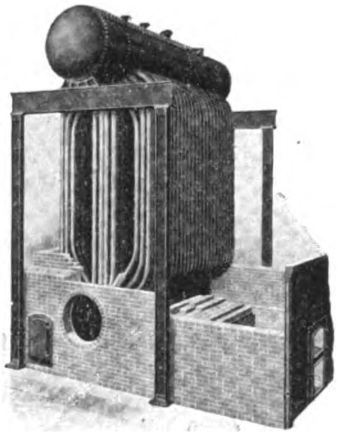
Section of water-tube boiler showing circulation of hot gases.



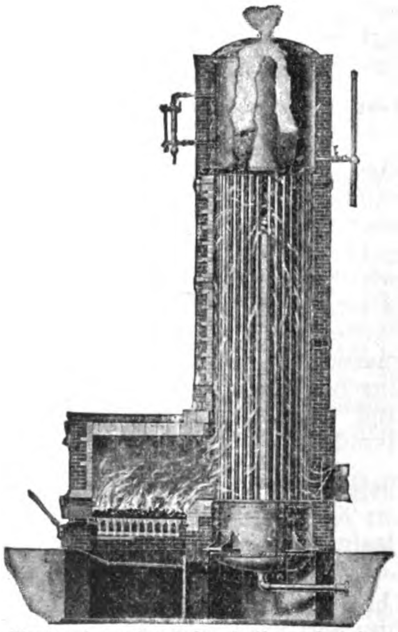
Same boiler as above partially erected.



Sectional view of a type of water-tube boiler.



Vertical water-tube boiler.

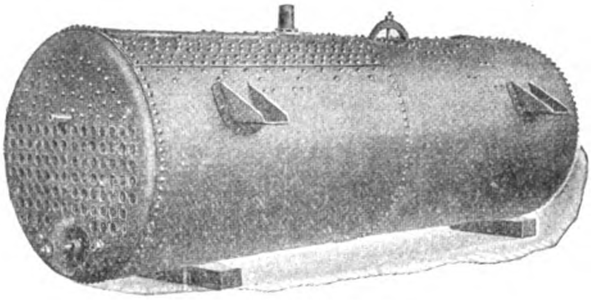


Vertical water-tube boiler showing circulation of furnace gases.

Fire-Tube Boilers

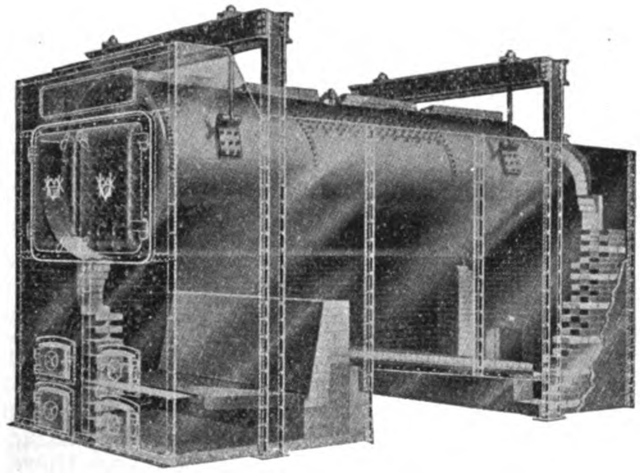
Fire-tube boilers are cheapest in first cost but have lower capacity per unit space. In general, they are the most difficult to keep in good operating condition, especially with dirty water, because of the inaccessible water space.

As a class, fire-tube boilers have quick steaming properties, but, from the standpoint of safety, are least desirable in large sizes, for the reason that they carry a large body of hot water, storing considerable energy which can be liberated at the instant and point of rupture.



Cylindrical fire-tube boiler.

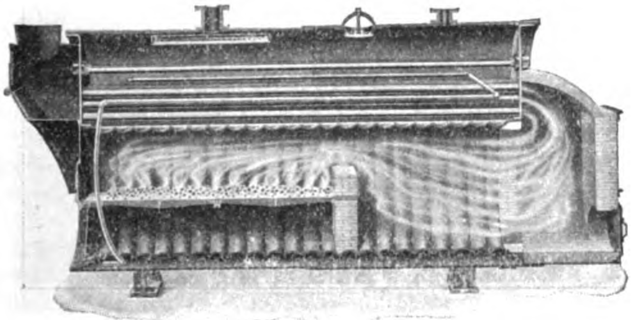
For plants where the load fluctuates, and where high pressure steam is used, the water-tube boiler seems to be safer, more economical and finds greater favor than fire-tube boilers.



Translucent view of fire-tube boiler and setting.

In the smaller or more temporary plants using relatively low pressures the fire-tube boilers are more frequently installed because of the cheaper initial and less maintenance cost. Fire-tube boilers are usually hand-fired, which in many cases means a poor economy in fuel.

The life of all boilers is from 12 to 35 years, depending upon the care and kind of feed water.



Section of return tubular boiler.

Boiler Settings

Present-day settings are almost universally of brick work. Sound, well-burned and uniform red brick are used in those portions of the setting which are well protected from extreme heat, and carefully selected fire brick used for the walls and arches where high temperatures may exist.

To a great extent, the life of the setting is dependent upon the fire brick selected. The best fire brick are manufactured from the clays of Pennsylvania, while south and west from this locality the quality becomes poorer in proportion to the distance. Past experience has shown that the real basis on which to judge fire brick from the boilerman's standpoint is the plastic property under a given load and temperature. The temperature at which the brick show a tendency to become plastic and deformed should be well above the working temperature.

A method of testing brick for this characteristic is as follows:*

"A standard fire brick tested on end should show no serious deformation and should not be compressed more than one inch in nine inches, when subjected to a load of 50 pounds per square inch and a temperature of 2462 degrees F."

If the setting is to support the boiler the outside walls must be at least 13" thick. The more favorable construction, however, is a 21" wall with a 2" or 4" interior air space. For walls between batteries the interior airspace has no value; therefore, in this instance, the 17" solid wall becomes more suitable.

If the boiler is supported upon an iron structure the brick shell is for the purpose of retaining the gases only, and under these conditions a 13" wall with a suitable casing will meet all the requirements.

Red brick should be laid in thoroughly mixed mortar made up of one volume cement, three volumes unslaked lime and 16 volumes sharp sand. All fire brick should be dry when used, each brick dipped in fire clay wash, rubbed and shoved into place, and tapped lightly with a wooden mallet until it touches the brick below it. The fire clay acts as a filler rather than a binder and no wash should be used which has a consistency that allows the use of a trowel. The fire brick linings should be laid up four courses of headers and one stretcher. All furnace center walls should also be made entirely of fire brick.

The brick walls alone should not be depended upon to keep the losses due to infiltration of air into the setting at a minimum. These losses in some cases amount to as much as 10% in poorly constructed settings; therefore, it is good practice to reduce the infiltration and keep down the losses due also to radiation by placing a steel casing about the setting. This casing should be backed by asbestoss mill-board, or better still, should be insulated from the brick by magnesia blocks and mill-board.

The ordinary return tubular boilers are provided with lugs, which rest on iron rollers, thereby permitting the boiler to expand freely. It is also common to hang both fire-tube and water-tube boilers from buck-stays suspended from an overhead structure, but no matter what method is used to provide for this expansion, the setting should be so designed that it will allow the boilers to expand without injury to the brick work.

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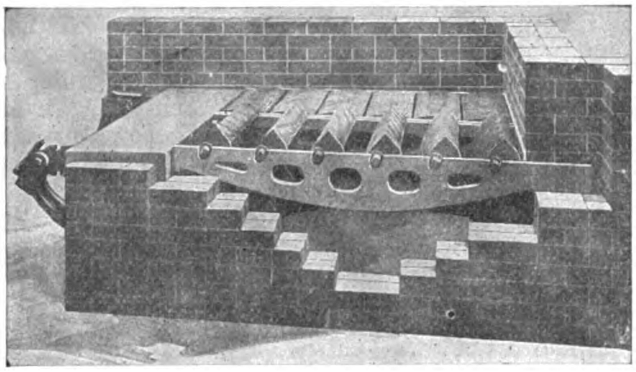
*Taken from Technologic Paper No. 7 of the Bureau of Standards.

Grates

Hand-firing grates are of three principal types: stationary, shaking and dumping. The first, stationary grates, may be subdivided into:

(a) Plain girder-shaped straight bars which are spaced from each other ¼″ to ⅜″ for the air supply and are held into units by lugs.

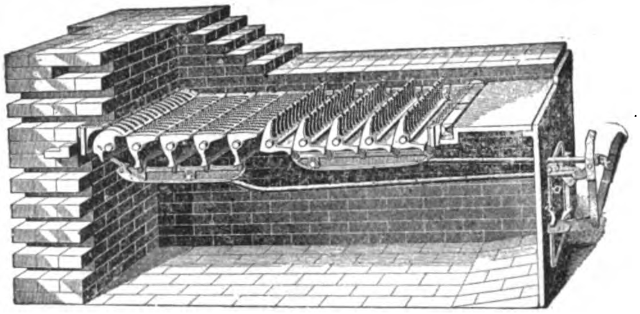
(b) Herringbone bars which are made up of two straight girder-bars spaced from 4″ to 6″ apart and are cast with herringbone-shaped tie ribs.


Type of self-dumping grates.

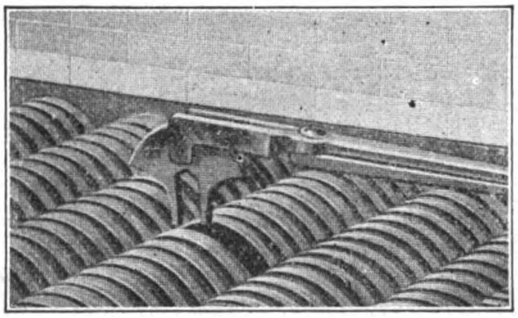
(c) Pinhole bars which have very fine perforations and are used for burning sawdust, very fine coal, culm, tan bark, and similar fuels.

Shaking and rocking grates are so made that the bars may be shaken or rocked in groups, to aid in cleaning the fires, or to be completely overturned and dump the fire entirely. These types are made in many different forms, and in some cases vary considerably from the simpler forms of stationary grates.

The choice of grates is dependent upon the kind and grade of fuel to be burned together with the clinker forming properties of the coal. In many instances where a stoker installation is not warranted, the rocking and self-dumping grates are very effective as a labor saving device. However, this type of grate should be selected with a view to its ability to dispose of clinkers and to withstand the extreme temperature without warping, and consequently hindering the movement of the grates.


Type of cut-off and dumping grates.

All grates should be very strong and should be interchangeable.

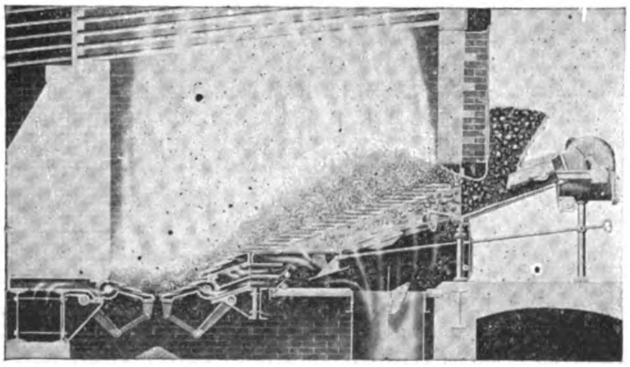

Type of rocking grates.

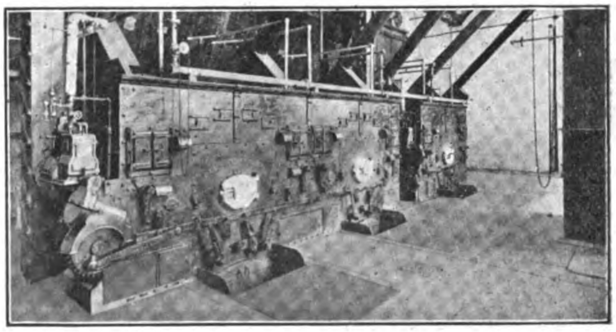
STOKERS

Stoker-fired furnaces have many advantages over hand firing, but in many instances, due to improper selection of type of stokers, the advantages do not warrant the increased expense of the installation. In large plants coal and ash handling equipment used in connection with stokers makes possible a large labor saving; however, in the smaller plants, the labor saving of stokers over hand firing is negligible, and the added cost in this latter case is not justified unless the smoke question is important, or a poor grade of fuel is to be used.

With respect to efficiency of combustion, other conditions being equal, there will be no great difference between the different types of stokers, provided the proper type is selected for the grade of fuel to be burned, and the conditions of operation are fulfilled. No stoker is built which will satisfactorily handle all grades of fuel, and each case therefore requires special consideration. A cheap stoker is a poor investment, and only the best stoker suited to the particular conditions should be considered, for if there is a saving the better grade stoker will more than repay the difference in initial cost.

Mechanical stokers are divided into three general classes: Over feed, under feed, and traveling grate.


Section of inclined underfeed stoker.


Outside view of same stoker.

Over feed stokers are built in two types. In the first type the coal is fed into hoppers at the front, and on to grates which are inclined downward. The grates are reciprocated alternately, and the motion carries the coal downward as it is burned until it reaches the flat dumping sections at the bottom where the combustion is completed. The fuel is partly burned or coked on the upper portion of the incline and the volatile gases liberated in this process are ignited and burned as they pass over the lower surface of hot coals or become mixed with the hot gases in furnace.

In the other type of over feed stokers, the fuel is fed into the furnace at the sides and on to rocking bars which form an incline toward the center. As in the previous type, the combustion advances as the coal moves toward the bottom, where clinker breakers are placed.

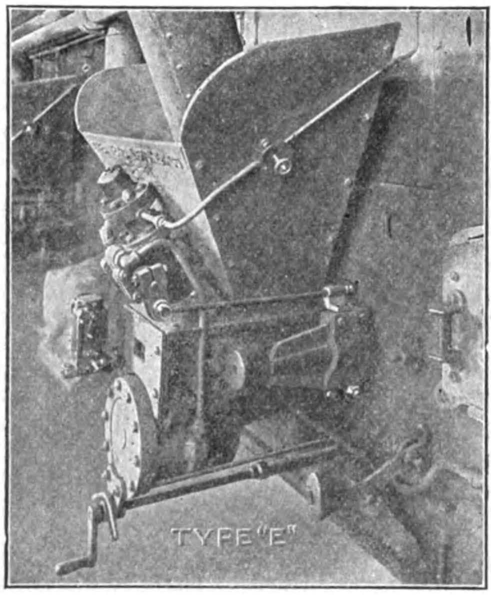
Under feed stokers are either horizontal or vertical. The coal is fed beneath the fuel bed either continuously by a screw or intermittently by plungers. This principle has a tendency to increase the efficiency and smokelessness of the combustion in that the green coal is fed beneath the coked and burning stratas, thereby forcing the liberated gases to pass through the hot portions of the fire at the top. In the horizontal type of under feed stokers the screw carries the fuel back through a retort and forces it upward as consumed. The ash and refuse is finally deposited on dead plates on both sides of the retort, from which place it can be removed.

Under feed stokers are usually operated with a forced draft, which in most cases is automatically regulated according to the rate of combustion by means of a mechanism synchronized with the stoker feed.

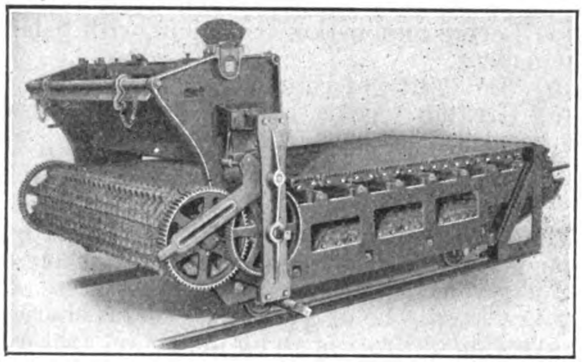
Traveling grate stokers consist of a number of short bars, linked into an endless chain which passes over sprockets at the front and rear of the furnace. The fuel is fed through suitable hoppers onto the forward end of the grate, is ignited at the front of the furnace, and is carried toward the rear as combustion progresses. When properly operated, combustion is completed when the fire reaches the rear, and the refuse only is carried over the rear sprocket.

Chain grate stokers in general are reputed to produce less smoke than other types, due to the fact that the cleaning is continuous and automatic, and no cleaning periods which produce unnecessary smoke are required. Another distinct advantage of chain grate stokers is that they can be withdrawn from the fire for inspection or repairs without disturbing the boiler setting. A disadvantage to this type is that considerable space is required which permits air leakage and a consequent cooling of the combustion chamber beyond the point at which volatile gases are ignited.

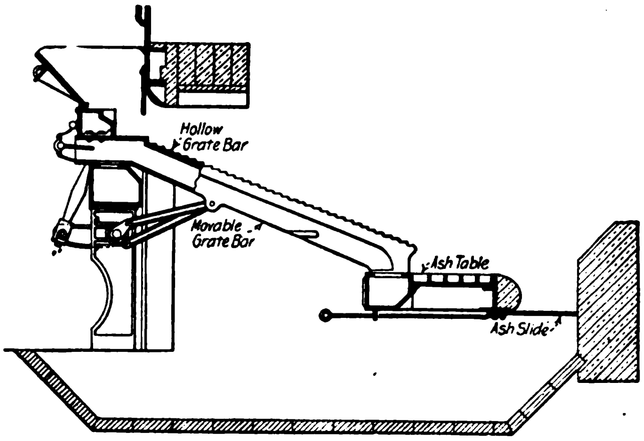
In general, for each kind of coal there is some method of firing which will give the best results for each individual set of conditions. Experience and practice only show what method best suits these specific conditions, therefore, considerable care should be exercised in selecting the proper type of stoker for the fuel to be used, otherwise the maintenance of the stoker plant may be two or three times as high as fire-room labor under hand-fired conditions.



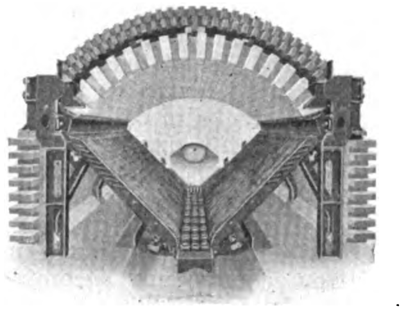
Reciprocating underfeed stoker—exterior view.



Perspective of chain grate stoker.



Sectional view of reciprocating stoker.



Perspective of side-feed stoker.

Mechanical Draft

For high rates of combustion, the size of stack to furnish the necessary amount of natural draft becomes almost prohibitive, and the heat loss due to high flue temperatures becomes excessive, therefore, to overcome these dufficulties the mechanical draft is used.

There are two general types of mechanical or artificial draft, the first in which the air from a blower is delivered into the ash pit under the grates, and the second in which a suction type fan is connected to the boiler flue and delivers into the stack. In this latter method the air pressure in the ash pit is less than atmospheric. Of the two systems the forced-draft is the most used because of the less maintenance cost, for in this system the fan handles cool air, while in the other system the deterioration of the fan is likely to be more rapid, because of its constant contact with the hot flue gases.

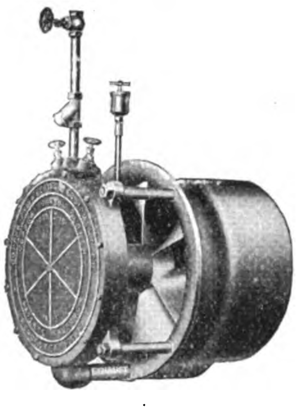
Forced draft combined with either natural or induced draft is always used with underfeed stokers, and frequently with chain grates.

The advantages of mechanical draft is:

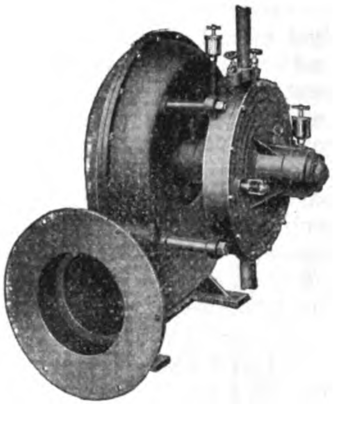
(a) Better combustion conditions with balanced arrangement.

(b) Flexibility of control.

(c) Greater forcing capacity than is possible with natural draft.



Turbo propeller blower.



Turbo centrifugal blower.

Forced draft ordinarily gives the best results when a pressure of .01 to .03 in. of water is maintained in the furnace above the fuel, thus allowing the natural draft to carry away the products of combustion.

A number of systems, especially where mechanical stokers are used, have automatic devices connected to the fan engine on motor for the purpose of maintaining the furnace air pressure at a certain value, thereby automatically controlling the rate of combustion.

FUELS

The composition of coal and the types of boiler furnaces vary over such a wide range that any suggestion given for the handling of different fuels must necessarily be of the most general character. The question of draft is an all important factor. If the draft is insufficient to draw the necessary amount of air through the fuel bed the combustion will be incomplete and the partially-consumed gases will pass off. On the other hand, an excess draft causes losses due to the cooling effect of the excess air and creates holes in the fire bed. There are rarely complaints, however, of excess draft where coal is burned, because the draft can be regulated according to the rate of combustion desired by means of the boiler damper.

Anthracite coal should be fired evenly, in small quantities and at frequent intervals, otherwise dead spots will appear in places, and if these dead spots become too frequent nothing can be done until the fire is cleaned and a new bed started.

No air should be admitted over the fire. Steam is sometimes introduced into the ash pit by means of a jet blower to soften clinker formation, but its use should be limited to the quantity only required for this purpose. An advantage in maintaining a high furnace temperature and an aid in the ignition of fresh coal is found by the use of combustion arches placed above the grates.

The blast required increases with the fuel bed thickness and the stacks in connection with forced draft should be of such a size to insure a slight suction under all conditions of operation. The blast when used with the finer sizes causes rapid fouling of the boiler heating surfaces; therefore, with this kind of fuel provision should be made in the baffling of the boiler for economically accommodating and disposing of this dust.

The difficulties encountered in the use of soft coal are due to the volatile matter present, and it is essential that the furnace be designed properly to handle this portion of the fuel. The fixed carbon will cause no difficulty if the volatile matter is properly burned.

Due to the volatile content in certain grades of bituminous coals, the best results have been obtained by burning the coal under fire brick arches. These increase the temperature of the furnace and maintain the heat that is necessary for the complete combustion of the gases. In some cases also additional combustion space is required in connection with the arches, and this is obtained by an extension of the furnace.

The percentage of volatile matter also affects the depth of the fuel bed and the method of firing, and for satisfactory results the following suggestions are given: Pocahontas, New River and Clearfield coals require beds of from 10 to 14 inches thick fired at intervals of 10 to 20 minutes, with sufficient fresh coal to maintain a uniform thickness. Coals from the Pittsburgh region require beds 4 to 6 inches thick fired often in small charges. Kentucky, Tenessee, Ohio and Illinois coals require a thickness of 4 to 6 inches, while with the free-burning Southwestern coals the best results have been obtained by fire beds from 6 to 8 inches thick. As the thin fires become necessary there will be a tendency to clinker if the thickness is increased, therefore, thin fires require that the charge should be small and at frequent intervals.

In the coking method of hand firing, the object is to preserve a bed of carbon at the rear of the furnace, so that the gases liberated from the green coal which is fired at the front will be forced to ignite as they pass over the hot carbon. Modern practice, however, leans more toward the spreading method, and there is a tendency to work the fires less than formerly.

In the spreading method of hand firing the coal is fired in small changes and spread evenly over the bed. The best results seem to be obtained by this method and almost complete combustion results, if proper depth of fuel bed is maintained.

Bone coal and refuse from picking tables is of questionable value when used as a boiler fuel under ordinary circumstances. It is a problem which requires special consideration and should not be used in connection with existing plants unless the present boiler capacity is more than ample to care for the requirements.

For satisfactory results this kind of fuel requires specially designed furnaces, grates and combustion chambers, and in most instances stokers and ash conveyors are necessary so that the labor factor will not offset the saving due to the use of the cheaper fuel.

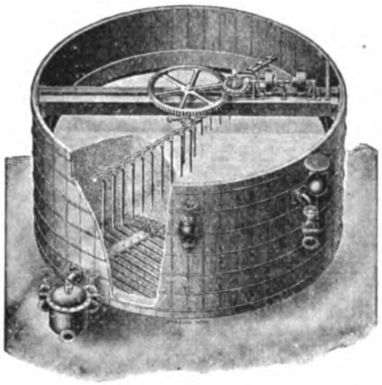
BOILER FEED WATER

The dangerous impurities in feed water are sulphuric acid, grease and oils in quantitiec, and the natural scale-forming salts, such as magnesia, iron and calcium carbonates and sulphates.

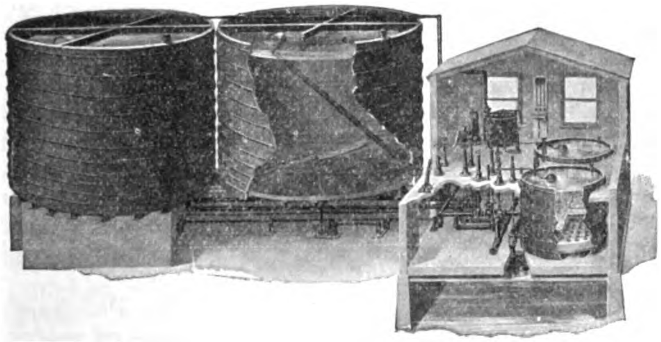
Ordinarily, when the supply of water available is not of sufficient purity for direct use in the boiler, some process of treatment must be resorted to, or sufficient boiler capacity must be installed to allow for regular cleaning; however, it is almost universally true that the interest and depreciation on the added boiler capacity will amount to two or three times the cost of treating the water.

It is evident that the subject of boiler feed water is a problem for the chemist rather then the engineer; however, the principal difficulties and remedies will be stated here.

Boiler corrosion is caused either by direct oxidization of the iron by oxygen contained in the water, or by the reaction of some acids present in the water and having their source from the products of decomposition of impurities in the feed. Corrosion by oxidations is the more important, for the other canalways be avoided by proper treatment. Oxidation goes on continuously wherever dissolved air is present, and is much increased by the vibration or flexure of any particular point.


Sectional view of gravity filter.

The pitting action of acids may be overcome by neutralizing the acid with sodium carbonate, commercially known as soda ash. This neutralization should be carried to the point where the water will just turn red litmus paper blue.


View showing purifying plant arrangement.

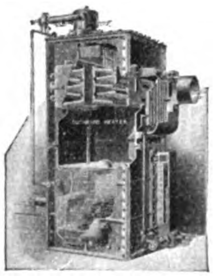
Air sucked in by the feed pump forms in bubbles below the water line and attacks the metal, the oxygen of the air causing oxidation of the boiler metal and the formation of rust. In this case, some means must be used to remove the air, either by placing a filter tank above the feed pump suction valves and introducing the feed water into the boiler in the form of a spray above the water line, or by allowing the air to attack zinc plates, which have a positive metallic contact with the boiler metal. This latter method is also most effective in attracting any galvanic action.

Incrustation is caused by the deposit of solid matter during the heating and boiling of the water. It may be merely a mechanically entrained impurity such as mud and sand, or it may be due to the precipitation of various salts insoluble in hot water or by supersaturation. These salts are usually precipitated and extracted from the feed water by the use of reagents, such as sodium carbonate or slaked lime. The efficiency of an apparatus for extracting these impurities will depend wholly upon the amount and character of the impurities.

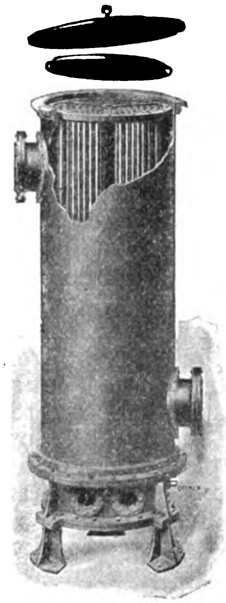
Feed Water Heaters

Feed water heaters are divided into three classes: Open heaters, closed heaters and economizers.

Economizers find their greatest application in Europe and in localities where the boiler efficieny must necessarily be low and the cost of fuel high, therefore, they will not be discussed here.


Open type Feed-Water Heater.

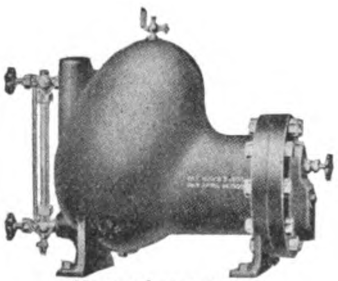
Open heaters are best suited for water containing scale-forming impurities, and in such instances the temporary hardness is here precipitated when the water is raised to the boiling point and the chemical reagent added. It is usually found, however, that when this class of apparatus is used in conection with bad water some of the impurities are not precipitated until after they reach the boiler.


Closed type Feed-Water Heater and Purifier.

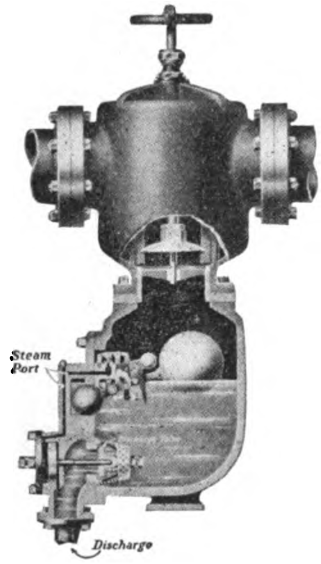
Closed heaters are best suited to waters containing no scale-forming impurities, for the reason that such impurities clog the heater, and cleaning them is costly. In this type the steam passes through tubes surrounded by the water or vice versa. The water and steam are never in direct contact. Closed heaters are not suitable for use with intermittently operating engines, such as hoists, etc., for the reason that frequent cooling and heating periods are likely to losen the tubes and destroy the heater. For this class of work open heaters should be used.

Steam Traps and Separators

The drips of the high pressure steam lines may densed water and returns it to the boiler or feed water heater. The traps usually consist of a container provided with a float controlled valve. When the container becomes full of condensed water, the valve automatically opens and discharges the water to its destination.


View of steam trap.

The valves of these traps should be of very good design, and made of the best material, otherwise they will fail to withstand the high steam pressure and a consequent loss of steam power is incurred.



Section of vertical steam trap.

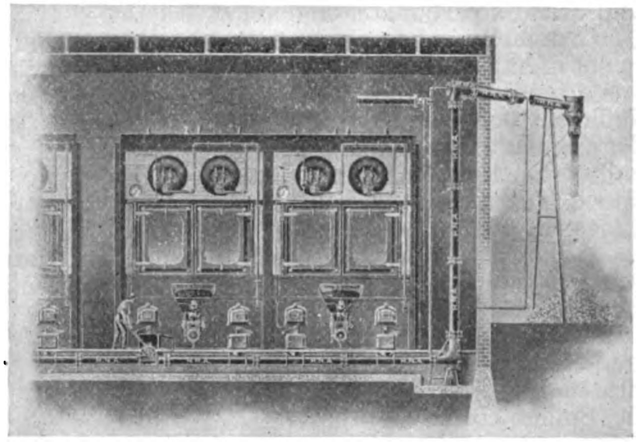
The steam separator is an enlarged fitting of the piping system, and is provided with baffle screns, corrugated surfaces or grids which collect the particles of water entrained in the steam. As the steam enters the separator its velocity is reduced and it is forced to travel in a zig-zag direction against the surfaces. The separated water particles are collected in a container at the bottom of the separator.

Coal and Ash Conveyors

Conveyors are of five principal types: Scraper, reciprocating, belt, bucket and suction. The scraper conveyor consists of flights or paddles fixed to a link chain and dragged along in troughs.

The reciprocating conveyor operates on the same principle but moves only a few feet backward and forward. The paddles of this type are so hinged that on the backward stroke they lift out and trail over the top of the coal, digging in again on the reversed action.

Belt conveyors consist of wide rubber, or textile, continuous belts traveling over idlers spaced two to four feet apart.


View of suction ash conveyor.

The bucket conveyor is made up of a series of separate buckets from 24 to 48 inches square, either fixed to long links or pivoted so as to remain vertical.

The suction conveyor consists of a 10-inch to 12-inch cast iron pipe fitted with swing-door openings to admit the ashes, and provided at the outlet with a high-speed centrifugal blower.

The belt conveyor is very satisfactory for carrying coal, but is not so good on "lift," and neither can it be used for ashes.

The bucket conveyor is probably the most satisfactory for all-around work, such as handling coal and hot ashes; however, it is also the most expensive. The suction conveyor is suitable only for ashes; coal is too heavy and packs too readily.

PIPING SYSTEM

The factors which should receive the most careful consideration in the design of the piping system are: the size of pipe to be employed, the methods used in reducing and disposing of condensation, and the means used in keeping the radiation losses at a minimum.

The consensus of engineering opinion on the question of material of pipes and fittings indicates that all pipe should be wrought iron, soft steel or cast iron. Pipe at present is made in three different weights, "standard", "extra strong" and "double extra strong", and the sizes, unless otherwise stated, are given in terms of the inside diameter. However, the difficulty in flanging wrought iron pipe has in some measure limited its use to plants which are located near where the pipe is manufactured.

The following are the standard specifications for power piping adopted by the Power Piping Society, June 24, 1917:

General Requirements

In the absence of a distinct specification by the Purchaser for material of a better grade, all material furnished shall conform to these specifications.

It is the intention that all material furnished hereunder shall be of the quality and weight which experience has shown to be safe and economical, hence the pressures specified are somewhat under those at which satisfactory service can be expected under favorable conditions, but as high as good practice will permit.

In the event of a specification by the Purchaser for service more severe for a given class of material than that given herein such material shall be furnished at the Purchaser's risk, and any guarantees for such material made hereunder become null and void.

Materials

Castings: All castings shall be smooth and free from injurious defects.

Cast Steel: The metal in steel castings shall conform to the requirements of the American Society for Testing Materials for "Medium Castings."

Semi-Steel: The metal in semi-steel castings shall have a tensile strength of not less than 30,000 pounds per square inch. A transverse test of the "Arbitration Bar," as outlined by the American Society for Testing Materials, supported 12 inches between centers shall show before breaking a load of 3,300 pounds and a deflection of not less than .12 inches.

Gray Iron: The metal in gray iron castings shall have a tensile strength of not less than 20,000 pounds per square inch. A transverse test as for Semi-Steel shall show before breaking a load of 2,900 pounds and a deflection of .10 inches.

Dimensions of Flanged Fittings

All standard and extra heavy flanged fittings shall conform to the center to face, thickness, and flange dimensions of the "American Standard," as recommended in 1914 by the A. S. M. E. Fittings used for working steam pressures 25 pounds and lower, and for water pressures 50 pounds and lower, may be lighter in the shell than the American Standard for 125 pounds working pressure.

Drilling and Facing of Flanges

All drilling of flanges shall conform to the templates of the said "American Standard," and shall straddle centers.

Standard flanges shall be plain faced. Extra heavy flanges shall have raised face extending to the inside edge of bolt holes.

Spotfacing and Backfacing

Flanges of Extra heavy Cast Iron or Semi-Steel material shall be either spotfaced or backfaced for all sizes 14 inch and larger. All Cast Steel flanges shall be spotfaced or backfaced.

Type of Joints

The following sizes are the smallest for which flanged joints will be required except for unions. Below these sizes screwed connections may be used.

Superheated Steam	2	inches
Saturated steam above 125 pounds	2½	inches
Boiler Feed	2½	inches
Exhaust	2½	inches
Low Pressure Water	2½	inches
Blow-Off	2	inches
Drains	2½	inches

Valves

Where Valves are required they shall be gate valves except for blow-off, or where their function is that of throttling, or for sizes smaller than ¾ inches, when they shall be either globe or angle valves.

All outside screw gate valves shall be back-seated to provide for re-packing under pressure.

Materials and test pressures for the various services shall be as follows:

Superheated Steam: Gate valves 2 inches and larger shall be extra heavy, outside screw and yoke pattern, with cast steel bodies, bonnets, discs and yokes; monel metal or 23 per cent nickel steel seats and disc rings; monel metal or 23 per cent nickel steel stems; and monel metal or 23 per cent nickel steel back-seating bushing below the stuffing box. Valves 8 inches and larger shall be by-passed.

Globe and angle valves 2 inches and larger shall conform to the same general specification.

All stop valves 1½ inches and smaller shall be extra heavy and shall be made of bronze containing not less than 10 per cent of nickel.

Valves shall be tested to 800 pounds hydrostatic pressure.

Saturated Steam Between 150 Pounds and 250 Pounds Per Square Inch Inclusive: Gate valves 2½inches and larger shall be extra heavy, outside screw and yoke pattern, with semi-steel bodies, bonnets, discs and yokes; bronze seats and disc rings; and bronze stems. Gate valves 8 inches and larger shall be by-passed.

Globe and angle valves 2½ inches and larger shall conform to the same general specification.

All valves 2 inches and smaller shall be extra heavy bronze.

Valves shall be tested to 800 pounds hydrostatic pressure.

Saturated Steam Between 125 Pounds and 149 Pounds Per Square Inch Inclusive: Gate valves 2½ inches and larger shall be medium, outside screw and yoke pattern, tested to 500 pounds hydrostatic pressure, with gray iron bodies, bonnets, discs and yokes; bronze seats and disc rings; and bronze stems.

Gate valves 10 inches and larger shall be by-passed.

Globe and angle valves 2½ inches and larger shall be extra heavy pattern, tested to 800 pound hydrostatic pressure, but other wise to the same general specification.

All valves 2 inches and smaller shall be extra heavy bronze, tested to 500 pounds hydrostatic pressure.

Boiler Feed Between 125 Pounds and 250 Pounds Per Square Inch Inclusive: Gate valves 2½ inches and larger shall be extra heavy, outside screw and yoke pattern, with semi-steel bodies, bonnets, discs and yokes; bronze seats and disc rings and bronze stems.

Globe and angle valves 2½ inches and larger shall conform to the same general specification.

Check valves 2½ inches and larger shall be extra heavy pattern, with bronze seats and disc rings.

All valves 2 inches and smaller shall be extra heavy bronze.

Valves shall be tested to 800 pounds hydrostratic pressure.

Exhaust: Gate valves 14 inches and larger shall be outside screw and yoke, low pressure pattern, suitable for 25 pounds working steam pressure, with gray iron bodies, bonnets, discs and yokes; bronze seats and disc rings; and rolled steel stems. Where space does not permit using outside screw and yoke, inside screw patterns may be used.

Gate valves 2½ inches to 12 inches inclusive, shall be standard pattern, outside screw and yoke, suitable for 125 pounds working pressure, with gray iron bodies, bonnets, discs and yokes; bronze seats and disc rings; and rolled steel stems.

Gate valves 2 inches and smaller shall be standard brass.

Suction and Low Pressure Water: Gate valves shall conform to the same specification as for "Exhaust" except that in every case bronze stems shall be used.

Check valves shall be standard pattern swing checks with bronze seats and disc rings.

Blow-Off: Blow-off connections shall be double valved.

Drains Between 125 Pounds and 250 Pounds Per Square Inch: Valves shall conform to the specification for those for "Saturated Steam between 150 and 250 pounds per square inch inclusive."

Low Pressure Drains: Valves shall conform to the specifications for those for **"Exhaust."**

Non-Return Valves: Non-return valves, either globe or angle type, shall be provided in each boiler connection. They shall work quietly, and shall automatically prevent the flow of steam from the lines to the boilers and shall be provided with means for closing by hand.

For Superheated Steam they shall be extra heavy, cast steel completely monel mounted, with monel metal pistons and dash pots if same are internal, and monel metal stems.

For Saturated Steam up to 250 pounds per square inch they shall be semi-steel, completely bronze mounted, with bronze pistons and dash pots and bronze stems.

Non-return valves shall be installed preferably with stems in a vertical position.

Fittings

Superheated Steam: Fittings 2 inches and larger shall be extra heavy, cast steel. Fittings 1½ inches and smaller shall be forged or cast steel.

Saturated Steam, Boiler Feed and Drains Between 125 Pounds and 250 Pounds Per Square Inch, Inclusive: Fittings 2½ inches and larger shall be extra heavy, semi-steel. Elbows for boiler feed shall be long radius where possible. Fittings 2 inches and smaller shall be extra heavy, gray iron.

Exhaust, Suction, Low Pressure Water and Low Pressure Drains: Fittings 14 inches and larger shall be low pressure, gray iron, suitable for 25 pounds working steam pressure. Fittings 12 inches and smaller shall be standard cast iron.

Flanged elbows for water shall be long radius where possible.

Blow-Off: Fittings shall be extra heavy semi-steel. Long radius fittings shall be used where possible.

Pipe, Flanges and Unions

Van Stone flanges shall fit the pipe closely. The lap shall be finished off to the inside edge of the bolt holes and faced with a fine tool finish.

Screw flanges shall be made up by machine where possible and all extra heavy flanges made up in the shop shall be refaced.

Steel flanges shall correspond in thickness to the flange of the American Standard for Fittings.

Superheated Steam: Flanges 6 inches and larger shall be high hub steel, Van Stoned. Flanges 5 inches and smaller shall be steel, screwed.

Saturated Steam Between 150 Pounds and 250 Pounds Inclusive: Flanges 6 inches and larger shall be low hub steel, Van Stoned.

Flanges 5 inches and smaller shall be extra heavy semi-steel screwed.

Saturated Steam Between 125 Pounds and 149 Pounds Per Square Inch Inclusive: Flanges 14 inches and larger shall be extra heavy high hub semi-steel Van Stoned.

Flanges 12 inches and smaller shall be extra heavy semi-steel screwed.

Boiler Feed and Drain Piping Between 125 Pounds ant 250 Pounds Per Square Inch Inclusive: Flanges shall be extra heavy semi-steel screwed.

Exhaust, Suction, Low Pressure Water and Low Pressure Drains: Flanges 14 inches and larger shall be standard cast iron pattern, Van Stoned.

Flanges 12 inches and smaller shall be standard cast iron, screwed.

Blow-Off: Flanges shall be extra heavy semi-steel, screwed.

Unions: On all screwed work a sufficient number of unions shall be used to facilitate repairs. One union shall be used near each screwed valve. Unions 1½ inches and larger shall be flanged and below 1½ inches they shall be gasketless, with non-corrosive seats.

Wrought Pipe

Wrought pipe shall be steel. Standard pipe shall be buttwelded for sizes 3 inches and smaller and lapwelded for sizes 3½ inches and larger. Extra strong pipe shall be buttwelded for sizes 2 inches and smaller and lapwelded for sizes 2½ inches and larger.

Steam Between 150 Pounds and 250 Pounds Per Square Inch Inclusive: Pipe shall be full weight 7 inches and smaller. Sizes larger than 7 inch shall be of the following thickness or weights per foot; 8 inch, 28.55 pounds; 9 inch, 33.90 pounds; 10 inch, 40.48 pounds; 12 inch, 49.56 pounds; 14 to 20 inch, inclusive, ⅜ inches; 22 to 24 inch inclusive, 7/16 inches.

Steam Between 125 Pounds and 149 Pounds Per Square Inch Inclusive; Suction and Low Pressure Water: Pipe shall be full weight 7 inches and smaller. Sizes larger than 7 inch shall be of the following thickness or weights per foot: 8 inch, 24.69; 9 inch, 33.90 pounds; 10 inch, 34.24 pounds; 12 inch, 43.77 pounds; 14 to 20 inch inclusive, 5/16 inches; 22 inch to 24 inch inclusive, ⅜ inches.

Boiler Feed: Pipe for pressure between 150 and 250 pounds per square inch inclusive shall be extra strong and between 125 pounds and 149 pounds per square inch inclusive, shall conform to the specification for "Steam" for the same pressures.

Exhaust Piping: Pipe 7 inches and smaller shall be full weight; 8 inch to 12 inch inclusive, shall be the same as for "Steam" between 125 pounds and 149 pounds inclusive; between 14 inches and 18 inches inclusive it shall be ¼ inch; and between 20 inches and larger it shall be of the lightest card weight.

Blow-Off: Pipe shall be extra strong.

Drains: Pipe shall conform to the specification for Steam Piping for the same pressure and service.

Welding: Where it is advisable economically, branches shall be welded to main piping, in preference to the use of fittings. All welds so made shall receive a hammer test under hydrostatic pressure three times the working pressure. The fillets and branches if buttwelded shall be built up to a radius equal to not less than three times the thickness of the pipe wall.

Bends: Bends shall be used for changes of alignment in preference to fittings. They shall be substantially round in section and free from injurious buckles. Radii equal to not less than 6 diameters of the pipe shall be used where possible.

Cast Iron Pipe

Where used for exhaust, suction, and low pressure water, Cast Iron pipe shall correspond in thickness to "Class A" pipe as specified by the American Water Works Association.

Bolts

All flange bolts 1½ inches in diameter and smaller shall have square heads and U. S. Standard hexagonal cold punched chamfered and trimmed nuts. For bolts larger than 1½ inches studs with two nuts may be used. When pulled up the bolt thread shall extend completely through the nut.

Gaskets

Gaskets shall fit inside of bolt holes for all lines not under vacuum. Vacuum lines shall have full faced gaskets.

Sheet Gaskets up to and including 12 inch size shall be 1/16 inch thick and for 14 inch and larger they shall be 3/32 inches thick.

Superheated Steam: Gaskets shall be superheated sheet or metal.

Saturated Steam; Boiler-Feed, Blow-Off and Drains: Gasket shall be Rainbow or equivalent, or corrugated copper.

Exhaust: Gaskets shall be Rainbow or equivalent.

Suction and Low Pressure Water: Gaskets shall be cloth inserted rubber or equal.

Supports

A sufficient number of supports, preferably hangers, shall be provided and so placed that their working stresses shall have a factor of safety of not less than six, assuming that each hanger is bearing its proportion of the load with the line full of water.

Sufficient anchorage shall be provided where necessary.

If roller supports are used they shall have screw adjustment.

Piping Not Shown

Piping and appurtenances such as drains, traps, priming pipes, gage and oil piping, etc., called for but not shown on drawings shall be furnished up to a value of $................................ for material only at prevailing market prices. Any lines ordered in excess of this amount shall be considered as extra work and shall be furnished at prices to be agreed upon between the Purchaser and the Company.

Size of Steam Lines

The factors which govern the size of steam lines are: the allowable steam velocity and the radiation loss. Radiation increases with the size of pipe, while the velocity of steam decreases; however, in modern practice there is a tendency toward the higher velocity, and 15,000 feet per minute is not unusual with superheated steam; formerly 6,000 feet per minute was considered the limit.

In "Power," June 19, 1915, Mr. F. A. Salmon presents the following formula as representing standard practice in determining the size of pipe:

$$d^2 = \frac{w}{k}$$

Where:

d—pipe diameter.
a—area of bore.
w=a×C=pounds of steam per hour.
C—a constant.

$$K\text{—}\frac{3.1416 \times C}{4}$$

VALUES OF K AND C.

Vacuum Hg. in inches	28	26	24	22	20	18	16	6	0
C	50	84	105	122	134	144	151	176	187
K	39.2	66	82.5	95.7	102	113	118.6	138	147
Gauge Pressure	80	100	125	150	175	200			
C	267	275	284	291	298	304			
K	210	216	223	229	234	239			

Piping System Design

Condensation of steam cannot be wholly overcome, and if the water is carried to the prime mover its effect will vary from disagreeable knocking to disruption, therefore, the problem of suitable traps and drainage systems should not be considered lightly. The pitch of all pipe should be in the direction of the steam flow and in the main feeder this slope should be about one inch in 10 feet.

Starting with the boilers, it is good practice to connect the various drums with a cross-over heading consisting of ball and socket joints connecting the drums and provided with a single main supply outlet at the top. At the top of this cross-over is placed an automatic check valve and stop, which allows the steam to pass from the boiler only and automatically closes should the steam velocity increase above a certain predetermined value due to a sudden drop in pressure in the mains.

From the outboard flange of the check valve the main boiler connection, made up of bent steel pipe with Van Stone flanges, is taken to the steam main. This connection is from 6″ to 10″ for a 650 boiler, and is provided with a gate valve.

The steam main is divided into sections by means of gate valves, which may be remote control by either electric or hydraulic means, but should in addition always be equipped with hand gear operating devices.

All auxiliaries which operate with the prime mover may be supplied from the prime mover steam main near the throttle, but these connections must always be made at the top or side of the main—never at the bottom.

Boiler feed pumps, fire pumps and other auxiliaries which operate independent of the prime mover are usually supplied from a separate steam system direct from the boiler drums or else are taken from points in the main which are always in service.

Each engine supply pipe should have its own separator placed as near the throttle as possible, and connected to a drainage system or high pressure drip system.

For the purpose of disposing of the condensate from the main a high pressure drip system is frequently installed. This system is made up of extra heavy pipe not over two inches, connected to the main at every fitting valve and separator and arranged to discharge into a drip tank or the boilers. A drip should always be placed between the check valve and gate valve in the boiler main, and as a matter of safety this should always be left open when the boiler is taken off the line for repairs or inspection.

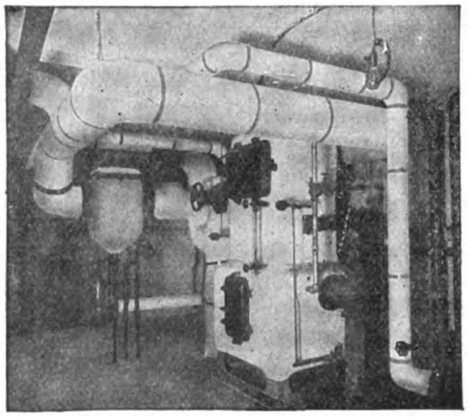
The high pressure feed water piping connecting the feed pump with the closed heaters, economizers and boilers is invariably made of three-quarter to one inch thick cast iron pipe and rarely exceeds eight inch sizes. This system usually consists of a row of piping under each row of boilers, from which loops of three-inch pipe are taken up over each battery and down again connecting with the main on the other side. The loop is usually provided with a check valve and hose connecting above the floor line, and the two parts of the loop are separated with a gate valve in order to provide for any line being thrown out of service. A check valve is usually placed in the two-inch brass connection which is taken from brass fittings above the boiler.

Exhaust connections are commonly made of cast iron pipe and flanges for sizes above 12 inches in diameter; below this size, however, the common practice is to use ordinary wrought iron pipe of such a size that the steam velocity will be from 20,000 to 35,000 feet per minute.

In the smaller non-condensing plants the exhaust is preferably run direct to the feed water heater and should have a sufficient slope away from the prime mover to drain the condensed steam, or else be supplied with suitable traps and drains.

Pipe Covering

Bare pipe radiates approximately 3 B. T. U. per hour per square foot per degree difference in temperature betwene the steam contact and external air, therefore, all exposed radiating surfaces, high pressure flanges, valve bodies, fittings, heaters and separators should be covered with suitable non-conducting material. The surface should be painted before the insulating material is applied, and the latter covered with canvas and held in place with suitable metal bands. The covering made into blocks should always be used except where it is impossible to install; in this case plastic material should be substituted.



Piping installation showing insulation.

PRIME MOVERS

In many classes of work it is difficult to select the proper type of prime mover unless a detailed analysis of the conditions is made, while in other classes the most suitable prime mover is readily apparent. The following summary, taken from a paper read before the A. S. M. E. in September, 1915, by J. S. Barstow, may act as a guide:

Applicability of Turbines

"1. Direct-connected units, operating condensing, 60-cycle generators in all sizes, also 25-cycle generators above 100 k. w. capacity.

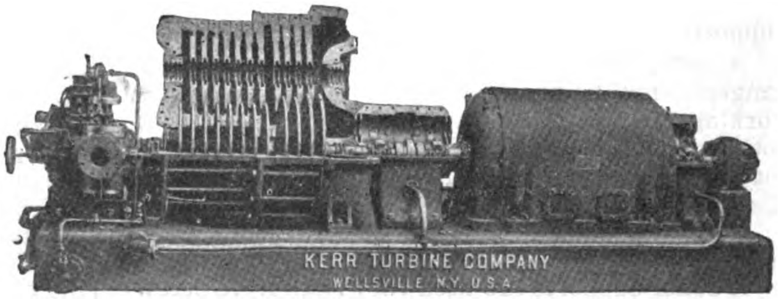
"Direct current generators in sizes up to 1,000 k. w. capacity, including exciter units of all sizes.

"Centrifugal pumping machinery operating under substantially constant head and quantity conditions and at moderately high head, say from 100 feet up, depending upon the size of the unit.

"Fans and blowers for delivering air pressures from 1½-inch water column to 30 pounds per square inch.

"2. Direct-connected units, operating non-condensing for all the above purposes, in these cases wherein steam economy is not the prime factor or where the exhaust steam can be completely utilized, and in the latter case, particularly where oil free exhaust steam is desirable or essential.

"3. Geared units, operating either condensing or non-condensing for all the above mentioned applications, and in addition, many others which would otherwise fall in the category of the steam engine on account of the relatively low speed of the apparatus to be driven."



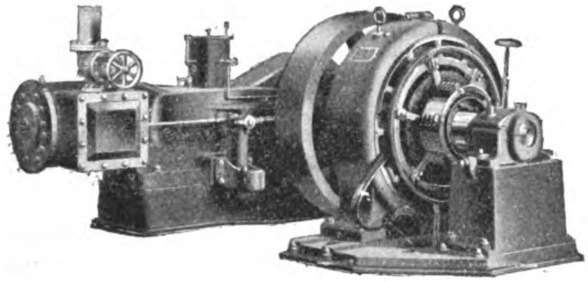
Steam turbine generator unit.

Applicability of Engines

"1. Non-condensing units, direct connected or belted and used for driving:

"Electric generators of all classes excepting exciter sets of small capacity, unless belted from the main engine.

"Centrifugal pumping machinery, operating under variable head and quality conditions, and at relatively low heads, say up to 100 feet, depending on the capacity of the unit.



Engine and generator unit.

"Pumps and compressors for delivering water or gases in relatively small quantities and at relatively high pressures—in the case of pumps at pressures above 100 pounds per square inch and in the case of compressors at pressures from one pound per square inch and above.

"Fans and blowers (including induced draft fans) for handling air in variable quantities and at relatively low pressures, say not over five-inch water column.

"Line shafts of mills, where the driven apparatus is closely grouped and the load factor is good.

"All apparatus requiring reversal in direction of rotation, as in hoisting engines and engines for traction purposes.

"3. Condensing units, direct-connected or belted, for all the above purposes, particularly where the condensing water supply is limited, and where the water must be re-cooled and re-circulated."

In general, high peripheral speeds are necessary in order that the turbine may efficiently utilize the energy from the steam. The turbine also shows its lowest water rate when operating at constant high speed. On the other hand, if a reciprocating engine is run at high speed the up-keep becomes excessive and the service unsatisfactory.

The speed required by the driven apparatus has in many cases in the past dictated the use of engines in place of turbines, although improvements in high-speed gearing, generators, pumps, etc., has greatly increased the use of turbines.

Small high-speed auxiliaries driven by reciprocating engines have previously required close attention and frequently overhauling, therefore, in all central stations where the main units are few in number, turbine-driven circulating water pumps and hot-well and boiler-feed pumps represent standard practice.

In induced-draft systems load fluctuations may require frequent changes in speed, and here a well-designed engine would be more satisfactory, also when large quantities of water are to be pumped against low variable heads the turbine would be unsatisfactory.

For direct-connected alternators that have a frequency of 25 cycles, the maximum speed is fixed at 1,500 R. P. M., which is too low for the efficient use of turbines. Also direct-current machines in the larger sizes give commutation troubles when operated at high speeds, and this disadvantage usually necessitates the use of engines.

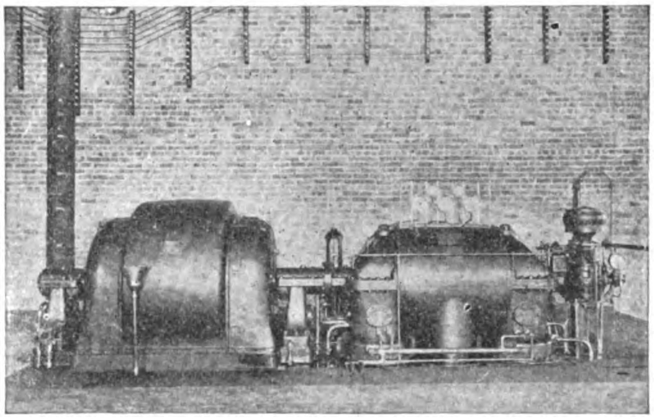
The steam engine usually develops mechanical difficulties when operated under high temperature and pressure conditions, and also large heat losses are incurred due to cylinder condensation. For this reason simple engines are adapted for low pressure while compound and triple expansion engines are more suitable for high pressures.

The turbine for high steam economy must be operated condensing, although there are many installations where steam economy is not the most important consideration, and the non-condensing turbine finds favor over the steam engine.

In plants where the exhaust is atmosphere and cannot be applied to useful purposes, the engine becomes the more suitable, provided the speed is low enough to insure smooth, quiet running.

For larger power requirements, the lower cost of turbines, the greater reliability of this apparatus for constant service, together with the smaller floor space required has practically put the engine out of the running for this class of work . The reduction gear is also very rapidly driving the engine from the direct current field, however, in the case of non-condensing units where moderate speeds are required, the engine must continue to hold its place.

It is often desirable to increase the capacity of first-class reciprocating plants. This may be done by the duplication of the engine units, by the purchase of complete expansion turbines or by installing low pressure turbines to operate from the exhause steam of the existing units. Local conditions usually determine which of these three methods should be used; however, it is safe to say that the reciprocating units will not be duplicated in plants of 1,000 H. P. or larger. In some cases it has been found advisable to add low pressure turbines, and in most instances the installation of complete expansion turbines will be the most economical solution.



Low pressure turbine generator unit.

STEAM CONDENSERS

The principal types of condensers are: Jet, barometric, inductor or syphon, rotary jet and surface.

The jet condenser usually consists of a cast iron shell into which the exhaust steam is led. Here the steam comes in contact with the spray of circulating water, is condensed, and the mixture pumped out at the bottom.

The barometric condenser is similar to the jet except that the contact of exhaust steam and circulating water takes place at a level higher than 34 feet above the discharge. The discharged water, therefore, is conducted away by gravity, but due to small friction losses in the piping, a small circulating pump is necessary for the supply.

In the inductor or syphon type of condenser, the water enters the condensing chamber under a pressure of 25 to 30 pounds and is given sufficient velocity to carry away the entrained air and condensed steam by kinetic energy. For this type no dry vacuum pumps are necessary.

The rotary jet type was first developed by Le Blanc, and consists of a centrifugal impeller which throws portions of water into a funnel-shaped nozzle in such a manner that the steam is entrapped and condensed between the small water pistons. This is merely a modification of the jet condenser, as are also all the other types heretofore described.

The surface condenser is made up similar to a fire-tube boiler. It consists of an outside shell, having water-tight box compartments at either end. The compartments are joined together with a large number of small brass tubes, which permit the water to traverse the shell without contact with the steam; the latter is fed into the center compartment around the tubes and when condensed collects at the bottom. When the circulating water enters the second compartment at the opposite end of the shell it may be either pumped out or re-directed through another set of tubes, or even again forced to pass through a third or fourth set of tubes. The first mentioned is called a single-pass condenser; the second a two-pass condenser, etc.

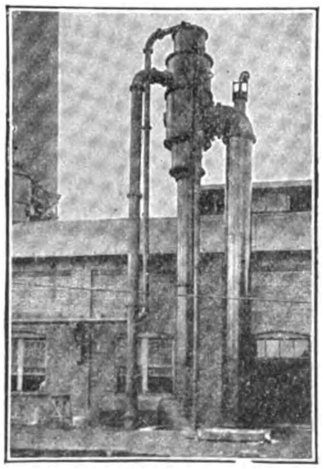
In some localities where the cooling water is limited in supply, a cooling medium consisting of a mixture of water and air is used for condensing purposes. The water enters in the form of a spray, takes up a certain amount of moisture, becomes cooled and then is brought in contact with the exhaust steam. This type is known as an atmospheric condenser, but with its use high vacuum cannot be obtained.

Jet condensers require from 20 to 35 pounds of circulating water per pound of steam condensed, while surface condensers require from 1.6 to 2.5 square feet of condensing surface per k. w. capacity of the plant.

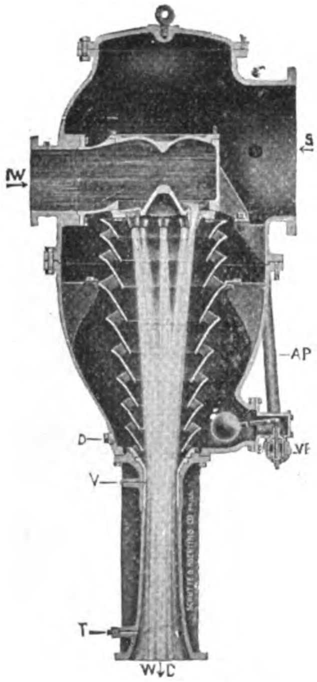
The type of condenser to be selected will depend largely upon the kind and quantity of circulating water available.

If the water is dirty a jet condenser should be used, and the mixture of condensate and water should be discharged into a drain and not re-used. Dirty water very readily deposits a non-conducting film on the tubes of surface condensers, thus greatly lowering the efficiency. It is a very tedious and expensive job to clean this type of condenser.

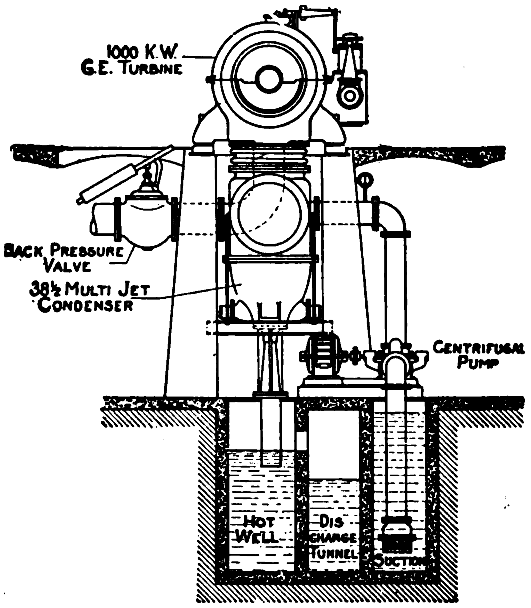
If the circulating water is clean and can be taken from a river or stream, a surface condenser should be selected. In this case the discharge water can be led back to the river. In many instances where the supply water is not available in sufficient quantity during the dry season, a small storage lake is formed and the water collected during the flood season. Cooling towers also are used to excellent advantage where the supply is limited. In these the discharge water trickles down over screens, usually set at angles, and comes in contact with an air blast. The humidity of the air increases as it passes up through the water, and the water temperature is in this manner lowered. From 10 to 20% of the water is carried away by the air.



Barometric condenser installation.



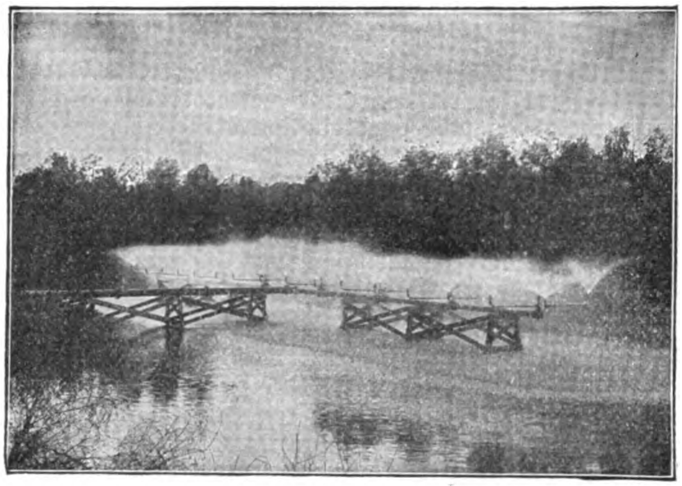
Section of jet condenser.



Multi-jet condenser.

COOLING PONDS

When the cooling pond is of sufficient area to dissipate the heat of the circulating water, no mechanical means of cooling this water becomes necessary, but if this area is limited, a usual method of facilitating the cooling is to introduce all or part of the water from the condenser over the pond surface in the form of spray. This action increases evaporation by breaking the water up into fine particles and may be necessary only during the summer months, or at such times that the water temperature becomes too high for economical operation. This process, in the same maner as coling towers, increases the humidity of the atmosphere thereby causing a loss of from 10 to 20 per cent of the water.



View of cooling pond.

GENERAL

When power is generated in a central plant and transmitted by electricity, a certain disadvantage is incurred, due to the fact that it is unprofitable to store electricity in quantities; it must be used as generated. This disadvantage has a direct effect upon the design of the plant and the selection of the apparatus, in that the prime movers and generators must have sufficient capacity to furnish the maximum instantaneaus peaks of the inherent variable load. This condition means that during the greater part of the time the machines will be working at something below full load, or in other words, below the point of best efficiency.

The degree of load variation for a given plant over a given period of time is recognized by a term called the load factor, which is defined as the ratio of the average load to the maximum load over a given period of time. The economics of a plant to a very large extent depend upon the load factor. In the very best designed plants these factors rarely exceed 35% and four or five per cent. is more common for small lighting plants.

It is, of course, desirable to keep the generators as near full load as possible, or expressed differently, to keep the load factor as high as possible. Various schemes in this direction have been tried out with god results, such as securing all the town lighting possible and collecting the mine water in sumps during the day and pumping this out at night. It must be remembered that the chief object is to distribute the load as much as possible over the 24 hours, so that any power requirement which does not necessarily have to be supplied when the main load is heavy should be postponed until night or at such times when the main load drops off. In this manner the capacity requirement of the prime movers drop off and the plant efficiency increases as continuous full load operation is approached.

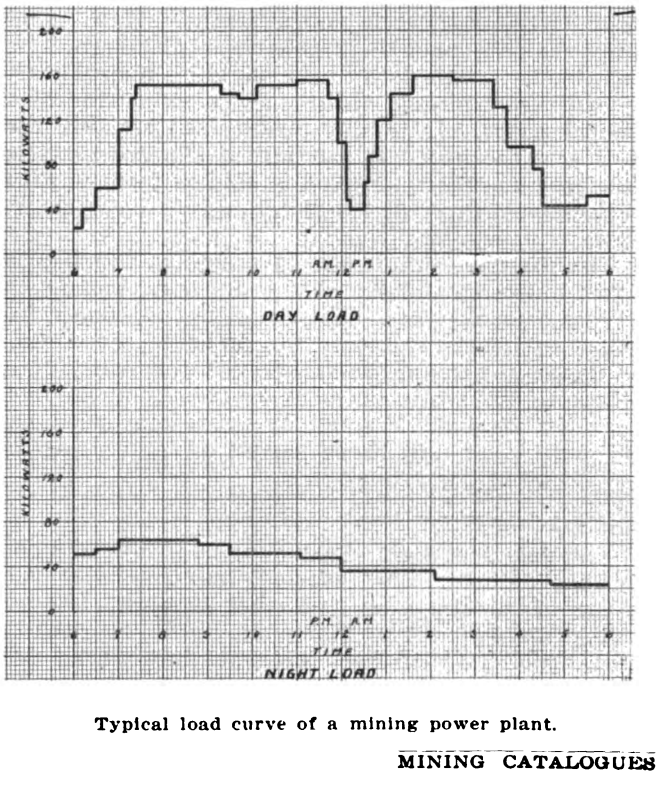
The load factor, then, is an indication of the load on the central plant and is independent of the kind of power generated. Another factor which must be considered in selecting apparatus is the diversity factor, which is the ratio of the total demand to the sum of the separate demands. It will be noticed that when several machines are being supplied from the same source the maximum demand of each machine will occur at different times, so that the maximum demand on the supply will be something less than the sum of the demands of the separate machines.

The diversity factor, like the load factor, is variable, depending upon the character of the load and local conditions. It may vary from 30% to 70% in different installations; however, in coal mining work 60% to 70% is a good average.

The best combination of plant economy is seldom, if ever, one in which each piece of apparatus is chosen by reason of its best water rate at full load. As explained above, the real essential is the characteristic of the machine under variable load and the heat relation to the rest of the plant.

It is always desirable to have at least one spare unit, in case of breakdowns, and no unit should be of such a size that it cannot at any time be taken from the line without overloading the other machines.

For good service and economy of operation all units should be of the same size and make, as there is always the increased risk of shutting down and increased cost, due to the interchangeability of units and spare parts.



Typical load curve of a mining power plant.

ELECTRIC AND TRANSMISSION LINES

While metal and concrete poles and steel towers may be used for the more important transmission lines, the wood pole construction still has a wide field of application, especially where the transmission lines pass through country in which suitable pole timber grows. Therefore, in considering the transmission of power throughout coal mining districts, it will here be assumed that the wooden pole offers the more convenient type of construction, and very little reference will be made to steel towers.

Selection of Poles

Cedar and chestnut are most commonly used for pole timbers. These are selected from sound, mature, well-grown trees, which are cut while the sap is down (during the winter months), and preferably seasoned for several months being placed in the lines. Experience indicates that young wood is more apt to decay than the wood of older timber, owing to its large content of albuminate in which destructive fungi flourish.

The item of seasoning may amount to as much as two or three years in the life of the pole, and for best results all poles should be stripped of bark and then seasoned under cover for several months until thoroughly dry.

There are many methods of treating timbers which are constantly exposed to the weather and ground, but owing to the comparatively late introduction of these processes their relative merit is not yet fully determined. Some of these treatments are: Creosoting, Kyanizing, Burnetizing and Vulcanizing, all of which tend to retard decay by either extracting the natural sap and forcing into the wood a preservation compound, or by simply neutralizing the sap. These treatments have as yet not come into extensive use except in southern climates, where the upper portion of the pole decays nearly as rapidly as the butt, and where the tropical insects, marine worms, and water have destructive effects on unprotected wood.

The tops of the poles are usually cut wedged shape or trimmed to a conical shape. Many companies do not treat their pole tops, although it is desirable to retard decay by applying a liberal coating of linseed oil and white lead, or some kind of a mineral paint. It is also preferable to paint the gains and the adjacent portion of the cross arms, for where one piece of wood is held in contact with another moisture collects and fungi of decay flourish.

The common practice is to use poles from 30 to 45 feet in length and placed in the ground to a depth of from 5 to 6½ feet. This length is of course increased to meet requirements of crossing, trees, etc., and under no circumstances should poles carrying a voltage of 220 volts or more be less than 20 feet above the ground. Frequently extra long poles are originally used and these sawed off and reset as they decay at the ground line.

Pole Spacing

The pole spacing is dependent upon the number and size of conductors carried, together with the nature of construction (whether straight line or having angles). The following table represents substantial practice for straight line work; for curves or angles, however, this spacing must be shortened.

Number of Conductors.	Size of Conductors.	Top Diameter of Pole.	Spacing of Pole.
3 to 6	Nos. 6 to 1	7 inches	150 feet
3	Nos. 0 to 4/0	8 inches	125 feet
6	Nos. 0 to 4/0	8 inches	110 feet
3	250,000 C. M.	9 inches	100 feet
6	250,000 C. M.	10 inches	80 feet

Cross Arms

The kinds of wood most largely used for cross arms are: Yellow Pine, Oregon or Washington Fir, Cedar, Cypress and White Pine. The standard arm is 3¼ inches by 4¼ inches; however, the longer length of arm required in high tension lines makes special arms necessary. These are made to order in sizes from 4x4 inches to 5x7 inches.

The length of the arm is determined by the number of conductors and the voltage carried. The spacing of conductors is taken up below, and reference is made to this table.

The cross arms are fastened to poles by a single through bolt fitted with square washers, and each side of the arm is braced from the bottom by means of galvanized steel braces. These braces are usually set at an angle with the pole from 45 to 60 degrees, and are fastened at the bottom by a single ⅝x3½-inch lag screw.

Double arms are necessary on terminal poles where the conductors are dead ended, on spaces over 150 feet, at angles of more than 20 degrees in the line, and where the cables are very heavy.

Double arms are held intact either by means of blocks inserted and held with through bolts or by means of long threaded bolts fitted with double nuts and square washers.

Pole Guying

Pole guying is commonly left to the judgment of a good construction foreman, and each company usually has their own standard methods. In general, however, the following rules should be followed:

1. The cable should be at least No. 3 galvanized steel stranded wire for light strain and from 5-16-inch to ½-inch cable for medium and heavy strains.
2. All guys should be placed before stringing the conductors.
3. Every pole which forms an angle of 10 degrees or more from the fixed direction of the line should have its spacing with the adjoining poles shortened by one-third or more, depending upon the angle, and should be properly guyed to counteract the pull of the conductors.
4. The guy cable should be given one complete turn around the poles and securely clamped with a 3-bolt galvanized iron clamp. At the anchor end the cable should be protected by a thimble where it passes through the eyelet.
5. There are several types of patent guy anchors on the market which can be easily installed, but care should be exercised in choosing the type of anchor suitable for the character of the soil. For regular country construction, the old log and guy rod combination seems to more popular than any other type of anchor. They are, however, a little more costly to install.
6. Strain insulators of the spherical type should be inserted in all guy wire about 6 or 10 feet from the pole.
7. Pole bracing should take the place of guy wires where it is inconvenient to run the cable.

Insulators

Fogs, rain, dust and severe electrical storms all have an influence on the choice of insulators. In general, however, since insulator manufacturers have no real rating standard, and because of the fact that an insulator is always chosen with a safety factor to cover extreme conditions of climate and surges, the matter of choice has no distinct dividing line.

Porcelain and glass insulators may be obtained up to 20,000 volts, but the present demand seems to favor porcelain for voltages of 20,000 or more, and the base of the pin should fit the cross arm snugly.

Below 20,000 volts wooden pins or pins made up of a wooden bushing and steel pin may be used.

Conductor Spacing

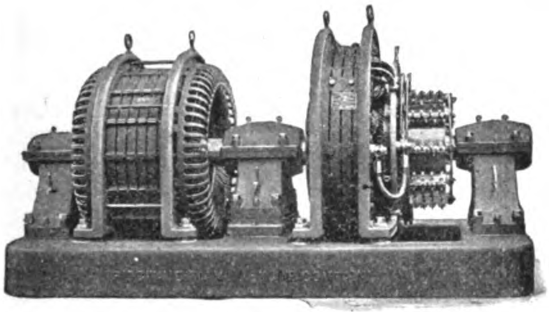
The spacing should be such that the wires cannot swing within arcing distance of each other in the span, and will, therefore, depend upon the length of span. The following table represents good practice:

Line Voltage.	Interaxial Spacing.
2,200	18-inch
500	24-inch
1,500	40-inch
30,000	48-inch

SUB-STATIONS

It has been previously pointed out that electric power can be transmitted at a high efficiency provided the line voltage is high, and for this reason alternating current, because of the ease in which the voltage can be raised or lowered together with the high efficiency of the three phase system, is preferably used for transmission.

Alternating current motors, however, are inherently constant speed motors, the speed varying with the frequency, and have a high starting torque only under excessive current. There are, however, certain types of alternating current motors such as the series motor, which give good results in the smaller sizes, when operated at varying speed, but in the larger sizes these motors develop serious commutation troubles which prohibit their use. The phase wound induction motor, within recent years, has been perfected to such an extent that in the larger sizes, and where high voltage is permissible, it has supplemented the direct current series motor, for variable speed work.



View of motor generator set.

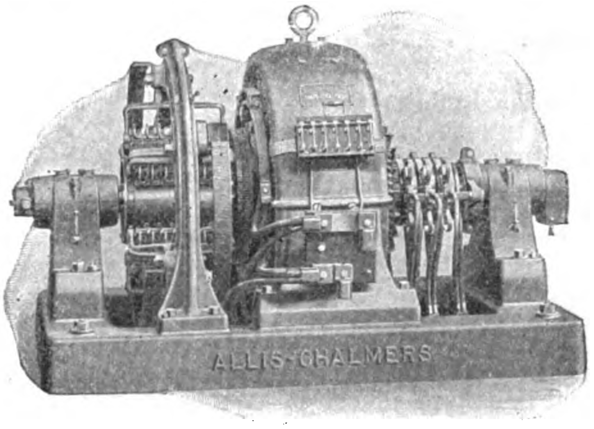
The main disadvantage to the induction motor, is the fact that current at starting and at low speeds is very high in comparison with the torque produced, and for this reason high short-interval peaks in the demand cannot be avoided.

For general inside mine work, such as locomotive, mining machines, etc., where variable speed and high starting torque is necessary, no type of motor is more popular than the series direct current machine, or a modification of the compound motor, therefore, if the power is transmitted by alternating current, and if direct current is to be used for the operation of the machines, some means of conversion becomes necessary.

There are several types and kinds of devices and machines on the market today, which convert alternating current in direct current or vice versa, but for the larger power requirements only two methods are found to be practicable; they are, the rotary or cynchronous converter method, and the motor generator method.

Synchronous Converter

The synchronous converter is much the same as a direct current shunt or compound wound machine having taps taken from the armature coils, into which the alternating current is introduced. When converting alternating into direct current, the machine operates as a combination of synchronous motor and direct current generator, and when converting direct current into alternating, it operates as a direct current shunt or compound motor and an alternator.



View of synchronous converter.

The efficiency of a synchrouous converter is very high, and including transformers will be from 3 to 5% higher than a motor generator set of equal capacity. The required floor space, exclusive of transformers, is also in favor of the converter, however, there are two distinct disadvantages which, in some cases, give the motor generator installation the preference. These are:

(a) The converter cannot be designed to correct the line power-factor as economically as the motor-generator, and

(b) There exists a definite ratio between the alternating current and direct current, so that only within very small limits, can the direct current voltage be varied when the alternating current voltage remains constant. This property of the converter sometimes causes annoyance when the supply voltage is unsteady or when it is desired to control the direct current voltage independent of the alternating voltage.

Motor Generator Sets

There are two types of alternating current motors which are used to a great extent in connection with D. C. generators for the purpose of converting alternating into direct current. These two types are the induction motor and the synchronous motor.

The simplicity and durability of the squirrel-cage induction motor has caused it to be the more popular of the alternating current motor where constant speed is desired, especially in the smaller sizes, and for all small sized and portable motor-generator sets, this type, no doubt, has the preference, however, in the larger sizes the induction motor draws a pronounced lagging current from the supply. This lagging or wattless current is undesirable in that it represents an unnecessary copper loss in the system, and also causes an added heating effect on the supply generators, therefore, in many cases it is good practice to use induction motors for pumps, fans, and other constant speed equipment, allowing the motors to draw a wattless current, but correcting this wattless current by a synchronous motor on the motor generator set. This type of motor when used for this purpose of power factor correction, supplies both energy and wattless current, and if properly designed, can be run at 75% leading power factor, thus, in most cases, supplying sufficient condenser effect to keep the resultant line power factor at a very good value.

The generator of the set should invariably be of the compound wound interpole type, and should be operated to over-compound from 15 to 20% from no load to full load. Under these conditions the generator will have a compensating effect on the line voltage drop as the load increases.

Substation Building

Substations like power plants should be made of fire-proof material throughout, either tile-brick or concrete, and should be located as near as possible to the direct current load center.

The building should also be designed with plenty of windows to furnish light and ventilation, and in many cases where floor space is limited and where more than one set is operating in the same room, it is desirable to place a ventilator in the roof. It should be remembered that the capacity of the set is limited almost entirely by its rise in temperature, so that an oversight relative to the ventilation item may result in unsatisfactory operation. As was previously mentioned, low voltage direct current cannot be efficiently transmitted over a distance much in excess of 4500 feet, so the matter of location becomes a very important item. The only factors which would make it desirable to locate the station outside of the load center are the items of an attendant and the necessity of a separate building. It frequently happens that the set can be placed near a ventilating fan or some other apparatus which requires an attendant, thus making it unnecessary to employ an extra man, or the sets are frequently located in the same building with a hoist, and in this way eleiminating both an attendant and an extra building.

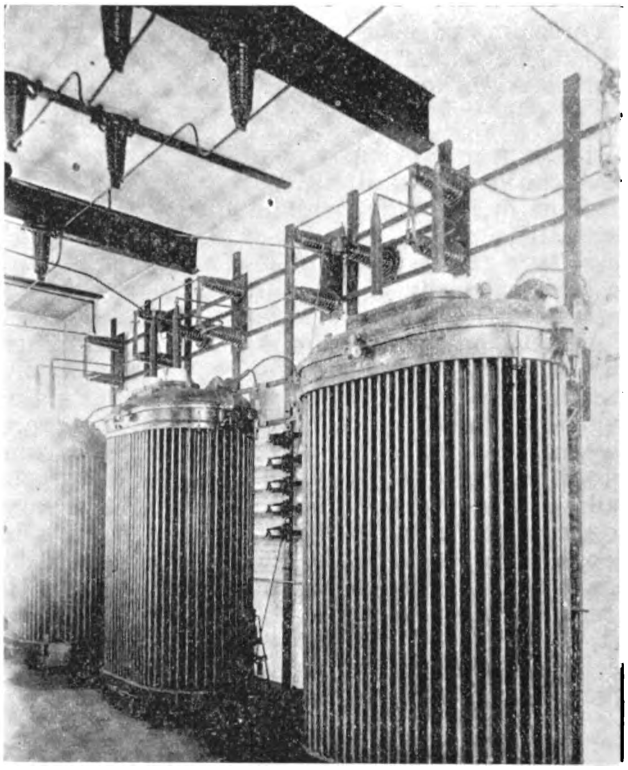
In recent years, the underground substation has become very popular. The high voltage cables are taken to the mine through a bore hole, drilled directly over the substation where they occasionally supply a large pump in addition to the motor generator sets.

The underground substation should be located in an air course to insure good ventilation, as well as located at the load center. The usual type of building construction in this case is brick walls, with the roof held intact by I-beams and concrete.

Transformers

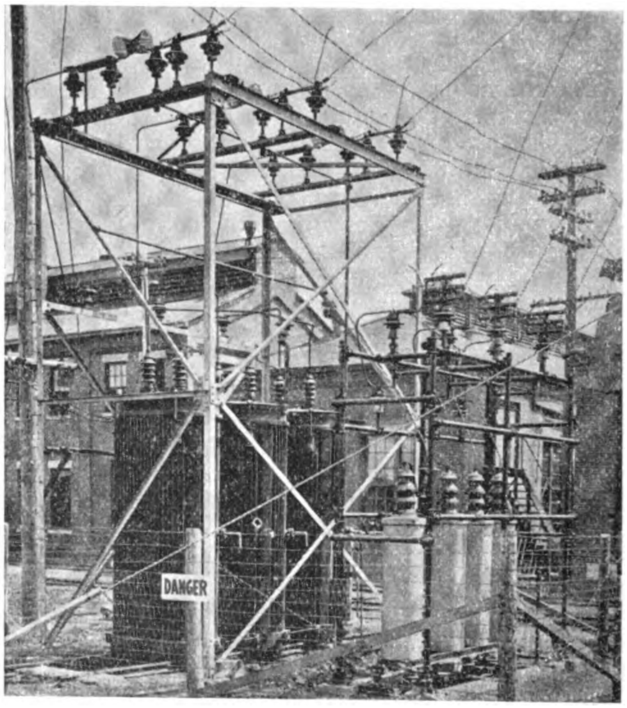
It is usually desirable to operate motor-generator sets and other surface motors, at a voltage of not more than 2200, and to operate underground alternating current motors on 440 volts, thus, in order not to lose the advantage of high voltage transmission, or if the voltage of transmission is 2200 volts, and it is desired to run alternating current to sub-surface equipment, it becomes necessary to use transformers to step the voltage down.

Transformers are built in various types and classes to operate on and provide for any of the standard voltages. They are also made for both outdoor and indoor operation. The usual and most convenient type, however, is the outdoor oil-cooled transformer.



View of indoor transformer sub-station.

Transformers can be placed almost anywhere, so long as they have god ventilation and are free from excessive dirt, and in the smaller sizes, are built for pole mounting, being suspended from a cross arm. They require practically no attention and operate at a very high efficiency, usually about 98%.



View of out-door transformer sub-station.

SWITCHBOARDS

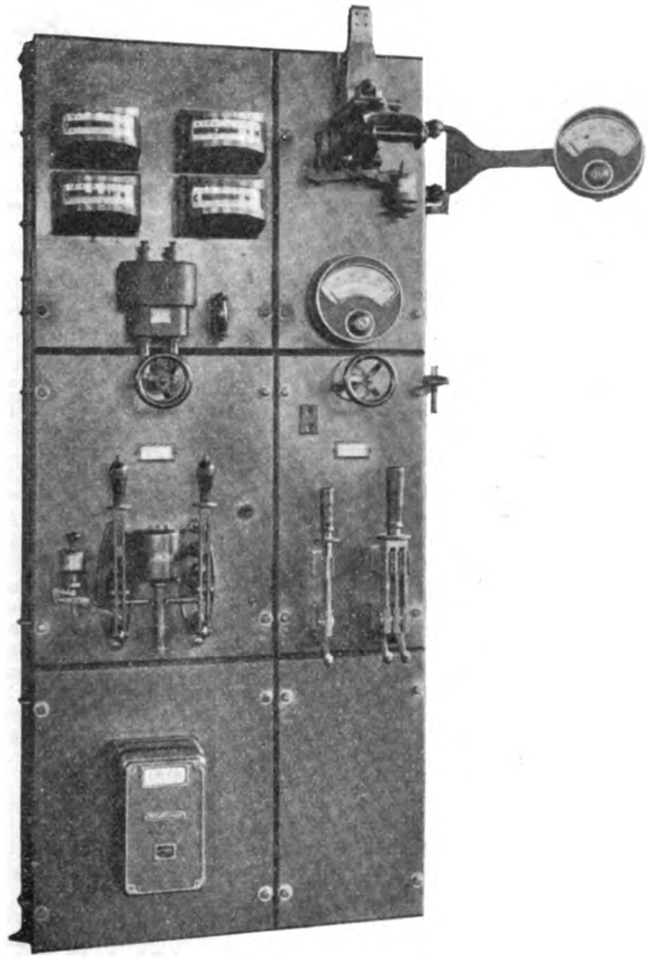
At the present time there are two materials which are extensively used for switchboard work; they are slate and marble. Slate, however, because of the comparative asee with which it can be worked, is more universally used, and is the material invariably found in mining installations. The panels are usually mounted on pipe or angle iron framework, and the whole supported on a wooden floor sill.

In general, switchboards, whether for a power plan, sub-station, or for anindividual motor, should be of the very best material throughout, and should have the instruments, transformers, switches, wiring, etc., neatly arranged without crowding, so that each part is readily accessible in case of trouble or repairs.

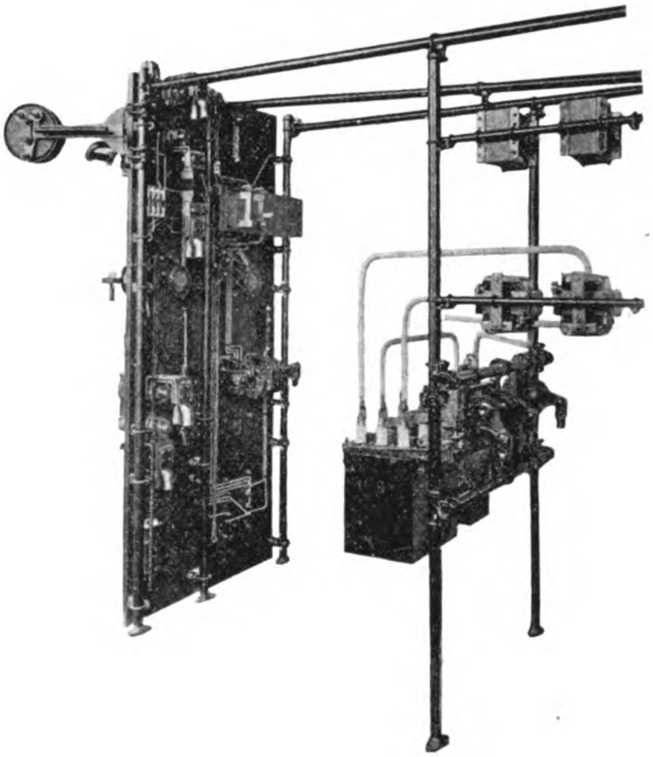
Each machine of any appreciable size, whether a motor or a generator, and each separate feeder circuit radiating from the power plant or sub-station should be controlled from a separate panel and switch, so that repairs on any individual line will necessitate an interruption only on a small part of the system.

The panels should all be of uniform height, thickness and finish and should be interchangeable and the switchboard as a whole so constructed and located that adidtional panels can be added when required.

The preferred arrangement is to place all alternating current panels on one side and all direct current panels on the other side. This sequence simplifies the wiring to a great extent and also is less likely to cause confusion when operating.



Front view of motor generator set switchboard.



Rear view of same switchboard.

Note—We are indebted to the following manufacturers for information and illustrations contained in this article:

Allis Chalmers Co.
American Steam Gage & Valve Mfg. Co.
Armstrong Cork & Insulator Co.
Babcock & Wilcox Co.
Ball Engine Co.
Combustion Engineering Corp.
Coppus Engineering Co.
Cyclone Grate Bar Co.
Detroit Stoker Co.
E. Keeler & Co.
Erie City Iron Wks.
Freeman Mfg. Co.
General Electric Co.
Geo. J. Hagen Co.
Green Engineering Co.
Harrison Safety Boiler Co.
Ingersoll-Rand Co.
Kerr Turbine Co.
McClave-Brooks Co.
Pittsburgh Filter & Mfg. Co.
Ridgway Dynamo & Engine Co.
Schutte & Koerting Co.
Sims Co.
Spray Engineering Co.
Union Iron Wks.
Valley Iron Wks.
Vogt Machine Co.
Walsh & Weidner Boiler Co.
Westinghouse Elec. & Mfg. Co.
Wickes Boiler Co.
Wm. B. Scaife & Sons Co.
Wm. H. Nicholson Co.

STANDARD SPECIFICATIONS
For
LAP-WELDED AND SEAMLESS STEEL BOILER TUBES, SAFE ENDS AND ARCH TUBES

[Including Superheater Tubes]
As Revised Jointly, 1913, by the

American Railway Master Mechanics Association
and the
American Society for Testing Materials.

I. Manufacture

1. **Process.** The steel shall be made by the open-hearth process.

II. Chemical Properties and Tests

2. **Chemical Composition.** The steel shall conform to the following requirements as to chemical composition:

Carbon ....0.08—0.18 per cent
Manganese ....0.30—0.50 per cent
Phosphorus ....not over 0.04 per cent
Sulphur ....not over 0.045 per cent

3. **Chemical Analysis.** (a) Analysis of two tubes in each lot of 250 or less may be made by the purchaser, which shall conform to the requirements specified in Section 2. Drillings for analyses shall be taken from several points around each tube.

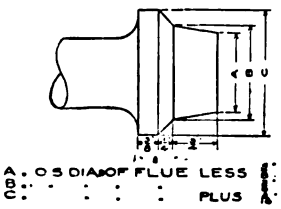
(b) If the analysis of only one tube does not conform to the requirements specified, analyses of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

III. Physical Properties and Tests

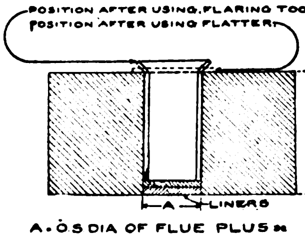
4. **Flange Tests.** (a) A test specimen not less than 4 inches in length shall have a flange turned over at right angles to the body of the tubes without showing cracks or flaws. This flange as measured from the outside of the tube shall be ⅜ in wide for tubes 2½ inches or less outside diameter, and ½ inch wide for tubes larger than 2½ inches outside diameter.

(b) In making the flange test, the flaring tool and die block as shown should be used.

FLARING TOOL.



DIE BLOCK.


POSITION AFTER USING FLARING TOOL.
POSITION AFTER USING FLATTER.
A
LINERS
A. O.S DIA OF FLUE PLUS

5. **Flattening Tests.** A test specimen 4 inches in length shall stand hammering flat until the inside walls are in contact, without cracking at the edges or elsewhere. For lap-welded tubes, care should be taken that the weld is not located at the point of maximum bending.

6. **Crush Tests.** A test specimen 2½ inches in length shall stand crushing longitudinally until the outside folds of metal are in contact, without showing cracks or flaws.

7. **Hydraulic Tests.** Tubes under 5 inches in diameter shall stand an internal hydraulic pressure of 1,000 pounds per square inch, and tubes 5 inches in diameter or over an internal hydraulic pressure of 800 pounds per square inch.

8. **Test Specimens.** (a) Test specimens shall consist of sections cut from tubes selected by the inspector representing the purchaser from the lot offered for shipment. They shall be smooth on the ends and free from burrs.

(b) All specimens shall be tested cold.

9. **Number of Tests.** One flange, one flattening and one crush test shall be made from each of two tubes in each lot of 250 or less. Each tube shall be subjected to the hydraulic test.

10. **Retests.** If the results of the physical tests of only one tube from any lot do not conform to the requirements specified in Sections 4, 5 or 6, retests of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

IV. Standard Weights

11. **Standard Weights.** The standard weights for tubes of various outside diameters and thicknesses are as follows:

WEIGHT IN POUNDS PER FOOT OF LENGTH.

Thickness		Outside Diameter in Inches.												
Inches	Nearest B W G	1¾	2	2¼	2½	3	•3½	•4	•4½	•5	•5¼	•5⅜	•5½	•6
0.095	13	1.68	1.93	2.19	2.44									
0.110	12	1.93	2.22	2.51	2.81	3.40								
0.125	11	2.17	2.50	2.84	3.17	3.84	4.51							
0.135	10	2.33	2.69	3.05	3.41	4.13	4.85	5.57						
0.150	9	2.56	2.96	3.36	3.76	4.57	5.37	6.17	6.97	7.77	8.17	8.37	8.57	9.37
0.165	8				4.11	5.00	5.88	6.76	7.84	8.52	8.96	9.18	9.40	10.28
0.180	7				4.46	5.42	6.38	7.34	8.30	9.27	9.75	9.99	10.23	11.19

12. **Permissible Variations.** The weight of the tubes shall not vary more than 5 per cent from that specified in Section 11.

V. Workmanship and Finish

13. **Workmanship.** The finished tubes shall be circular within 0.02 inch, and the mean outside diameter shall not vary more than 0.015 inch from the size ordered. The thickness at any point shall not vary more than 10 per cent from that specified. The length shall not be less, but may be 0.125 inch more than that ordered.

14. **Finish.** The finished tubes shall be free from injurious defects and shall have a workmanlike finish. They shall be free from kinks, bends and buckles.

VI. Marking

15. **Marking.** The name or brand of the manufacturer and "Tested at 1000 Pounds" for tubes under 5 inches in diameter, or "Tested at 800 pounds," for tubes 5 inches in diameter or over, shall be legibly stenciled in white on each tube.

VII. Inspection and Rejection

16. **Inspection.** The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the tubes ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the tubes are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and are to be so conducted as not to interfere unnecessarily with the operation of the works.

17. **Rejection.** (a) Tubes when inserted in the boiler shall stand expanding and beading without showing cracks or flaws, or opening at the weld. Tubes which fail in this manner will be rejected and the manufacturer shall be notified.

(b) Unless otherwise specified, any rejection based on tests made in accordance with Section 3, shall be reported within five working days from the receipt of samples.

18. **Rehearing.** Samples tested in accordance with Section 3, which represents rejected tubes, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the test, the manufacturer may make claim for a rehearing within that time.

Note*. It is regular practice to furnish for locomotive purposes sizes larger than 3" O. D. in Seamless only.

Quantity of Feed Water Required to Supply Boiler.

Horse-Power of Boiler.	Quantity of Feed Water Required.		Temperature of Feed Water. Degrees Fahr.
	Gallons per Minute	Pounds per Hour.	
50	3.60 to 4.20	1599 to 2029	100 to 212
100	6.57 to 7.63	3285 to 3815	100 to 212
200	13.14 to 15.26	6590 to 7630	100 to 212
250	16.43 to 19.07	8215 to 9535	100 to 212
300	19.71 to 22.89	9855 to 11445	100 to 212
400	26.28 to 30.52	13140 to 15260	100 to 212
500	32.85 to 38.15	16425 to 19075	100 to 212
600	39.42 to 45.78	19710 to 22890	100 to 212
800	52.26 to 61.04	26280 to 30520	100 to 212
1000	65.70 to 76.30	32350 to 38150	100 to 212
1200	78.84 to 91.56	39420 to 45780	100 to 212
1500	98.55 to 114.45	49275 to 57225	100 to 212
1800	118.26 to 137.34	59130 to 68670	100 to 212
2200	144.50 to 167.80	71290 to 83930	100 to 212
3000	197.10 to 228.90	98500 to 114500	100 to 212
3500	229.95 to 267.05	114975 to 133525	100 to 212
4500	295.65 to 343.35	147825 to 171675	100 to 212
6000	394.20 to 457.80	197100 to 228900	100 to 212
7000	459.90 to 534.10	229950 to 267050	100 to 212

Properties of Saturated Steam

(Peabody)

Pressure by Gauge, Lbs. per Sq. In.	Temperature of Steam, Degrees, Fahr.	Total Heat of Steam in B. T. U. above Water at 32° Fahr.	Weight of Steam, Pounds per Cubic Foot	Relative Volume, Water at 39° F.=1
0.	212.0	1146.6	.0379	1646.0
5.3	227.9	1151.5	.0507	1231.0
15.3	250.2	1158.3	.0742	841.3
25.3	267.1	1163.4	.0972	642.0
35.3	280.9	1167.6	.1198	520.5
45.3	292.5	1171.2	.1422	438.5
55.3	302.7	1174.3	.1643	379.3
65.3	311.8	1177.0	.1862	334.5
75.3	320.0	1179.6	.2080	299.4
85.3	327.6	1181.8	.2296	271.1
100.3	337.8	1185.0	.2617	237.6
105.3	341.0	1185.9	.2724	228.3
110.3	344.1	1186.9	.2830	219.6
115.3	347.1	1187.8	.2936	211.6
120.3	350.0	1188.7	.3042	204.2
125.3	352.8	1189.5	.3147	197.3
130.3	355.5	1190.4	.3253	190.9
135.3	358.2	1191.2	.3358	184.9
140.3	360.7	1192.0	.3463	179.2
145.3	363.3	1192.7	.3567	173.9
150.3	365.7	1193.5	.3671	169.0
155.3	368.2	1194.2	.3775	164.3
160.3	370.5	1194.9	.3879	159.8
165.3	372.8	1195.7	.3983	155.6
170.3	375.1	1196.3	.4087	151.6
175.3	377.3	1197.0	.4191	147.8
180.3	379.5	1197.7	.4296	144.2
185.3	381.6	1198.3	.4400	140.8
190.3	383.7	1199.0	.4503	137.5
195.3	385.7	1199.6	.4605	134.5
200.3	387.7	1200.2	.4707	131.5

Table Showing Cost of Evaporating 1000 Pounds of Water, with Different Grades of Fuel and Varying Evaporations.

Actual Evaporation per Pound Fuel	PRICE OF COAL PER TON									
	$0.75	$1.00	$1.25	$1.50	$1.75	$2.00	$2.50	$3.00	$3.50	$4.00
	COST OF EVAPORATING 1,000 POUNDS OF WATER									
5. lbs.	.0750	.1000	.1250	.1500	.1750	.2000	.2500	.3000	.3500	.4000
5.5 "	.0681	.0909	.1136	.1363	.1591	.1818	.2272	.2727	.3182	.3636
6. "	.0625	.0832	.1041	.1250	.1458	.1666	.2082	.2500	.2916	.3333
6.5 "	.0577	.0769	.0961	.1154	.1349	.1538	.1923	.2307	.2692	.3077
7. "	.0535	.0714	.0892	.1071	.1250	.1428	.1785	.2143	.2500	.2857
7.5 "	.0500	.0666	.0833	.1000	.1166	.1333	.1666	.2000	.2333	.2666
8. "	.0469	.0625	.0781	.0937	.1093	.1250	.1562	.1875	.2187	.2500
8.5 "	.0441	.0588	.0735	.0882	.1029	.1176	.1470	.1764	.2059	.2353
9. "	.0416	.0555	.0694	.0833	.0972	1111	.1389	.1666	.1944	.2222
9.5 "	.0394	.0526	.0657	.0789	.0921	.1052	.1316	.1578	.1842	.2105
10. "	.0375	.0500	.0625	.0750	.0875	.1000	.2250	.1500	.1750	.2000
10.5 "	.0357	.0476	.0595	.0714	.0833	.0952	.1190	.1428	.1666	.1994
11. "	.0340	.0454	.0568	.0681	.0795	.0909	.1136	.1363	.1590	.1818

Compressed Air Transmission

In theory there are two ideal methods of compressing and utilizing air, adiabatically or isothermally.

Adiabatic compression and utilization means that the air is compressed and expanded without transmission of heat to or from the gas.

Isothermal compression and utilization means that the air is compressed and expanded with the addition or rejection of sufficient heat to maintain the air at a constant temperature.

Single Stage Compression

The table shows the horse power required under the conditions named to compress one cubic foot of free air per minute to different gauge pressures by single stage compression.

In columns five and eight of the table below are shown the theoretical horsepowers required for isothermal and adiabatic compression. The results of isothermal compression are wholly unattainable in practice, and are placed here only for purposes of comparison. They represent an ideal which it is desirable always to keep in view. The figures given in the column of adiabatic compression are based on the assumptions that there is no radiation of heat from the air cylinder, and that the temperature of the air after delivery had become normal its volume being therefore reduced to that which is practically available for use. No allowances are included in these figures to cover losses other than that due to the heating of the air compression. But the full amount of loss represented by adiabatic compression can never be suffered in the operation of compressors, however imperfect their design. The actual compression line must always be lower than the adiabatic line, because of the radiation of heat through the cylinder walls. In ordinary, single-stage compressors, properly water-jacketed and run at a reasonable piston speed, the compression line falls considerably below the adiabatic line. Whatever diminution of loss is effected by cooling of the air in the cylinder may therefore be credited against the other unavoidable losses, partially offsetting them, viz: fractional or mechanical loss in the compressor, friction of inlet valves, heating of the intake air by contact with the hot metal surfaces, and piston clearance of the cylinder. These losses are variable in amount depending on the design of the compressor.

In the absence of indicator cards giving the actual results in individual cases, estimates based on practice may be made of the net power loss experienced in operating compressors, which will be convenient for reference. With this understanding, an attempt is made in column nine of the table to show the actual horse power required to compress one cubic foot of free air, under the condition stated at top of the column. Fifteen per cent, is assumed as a fair estimate in case of well designed and operated single stage compressors, of the additional power required, over and above that for theoretical adiabatic compression; this fifteen per cent. being taken as: the loss in purely adiabatic compression minus the effect of ordinary water-jacket cooling, plus the other three losses mentioned at end of preceeding paragraph.

The figures in columns five, eight and nine (which are for free air), if multiplied by the corresponding ratios of compression (Column 3), will give the respective theoretical and actual power costs of furnishing one cubic foot of compressed air, at the gauge pressure stated.

HORSE-POWER REQUIRED

FOR COMPRESSING ONE CUBIC FOOT OF FREE AIR PER MINUTE (ISOTHERMALLY AND ADIABATICALLY) FROM ATMOSPHERIC PRESSURE (14.7 POUNDS) TO VARIOUS GAUGE PRESSURES

Single-Stage Compression
Initial Temperature of Air Taken as 60° F.—Jacket-Cooling Not Considered

Gauge Pressure Pounds	Absolute Pressure Pounds	Number of Atmospheres	Isothermal Compression		Adiabatic Compression			
			Mean Effective Pressure	H. P.	Mean Effective Pressure Theoretical	Mean Eff. Pressure plus 15% Friction	H. P. Theoretical	H. P. plus 15% Friction
5	19.7	1.34	4.13	0.018	4.46	5.12	0.019	0.022
10	24.7	1.68	7.57	0.033	8.21	9.44	0.036	0.041
15	29 7	2.02	11.02	0:048	11.46	13.17	0.050	0.057
20	34.7	2.36	12.62	0.055	14.30	16.44	0.062	0.071
25	39.7	2.70	14.68	0.064	16.94	19.47	0.074	0.085
30	44.7	3.04	16.30	0.071	19.32	22.21	0.084	0.096
35	49.7	3.38	17.90	0.078	21.50	24.72	0.094	0.108
40	54.7	3 72	19.28	0.084	23.53	27.05	0.103	0.118
45	59.7	4.06	20.65	0.090	25.40	29.21	0.111	0.127
50	64.7	4.40	21.80	0.095	27.23	31.31	0.119	0.136
55	69.7	4.74	22.95	0.100	28.90	33.23	0.126	0.145
60	74.7	5.08	23.90	0.104	30.53	35.10	0.133	0.153
65	79.7	5.42	24.80	0.108	32.10	36.91	0.140	0.161
70	84.7	5.76	25.70	0.112	33.57	38.59	0.146	0.168
75	89.7	6.10	26.62	0.116	35.00	40.25	0.153	0.175
80	94.7	6.44	27.52	0.120	36.36	41.80	0.159	0.182
85	99.7	6.78	28.21	0.123	37.63	43.27	0.164	0.189
90	104.7	7.12	28.93	0.126	38.89	44.71	0.169	0.195
95	109.7	7.46	29.60	0.129	40.11	46.12	0.175	0.201
100	114.7	7.80	30.30	0.132	41.28	47.46	0.180	0 207
110	124.7	8.48	31.42	0.137	43.56	50.09	0.190	0.218
120	134.7	9.16	32.60	0.142	45.69	52.53	0.199	0.229
130	144.7	9.84	33.75	0.147	47.72	54.87	0.208	0.239
140	154.7	10.52	34.67	0.151	49.64	57.08	0.216	0.249
150	164.7	11.20	35.59	0.155	51.47	59.18	0.224	0.258
160	174.7	11.88	36.30	0.158	53.70	61.80	0.234	0.269
170	184.7	12.56	37.20	0.162	55.60	64.00	0.242	0.278
180	194.7	13.24	38.10	0.166	57.20	65.80	0.249	0.286
190	204.7	13.92	38.80	0.169	58.80	67.70	0.256	0.294
200	214,7	14.60	39.50	0.172	60.40	69.50	0 263	0.303

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Two and Three Stage Compression

The horse power for two and three stage compression at sea-level, both theoretical and actual, are given in the following tables, the figures in the col-umn headed "Horse power 15% friction," being taken as an approximation to the results obtainable in practice from stage compressors of the usual designs.

Horse-Power Required

For compressing one cubic foot of free air per minute (isothermally and adiabatically) from atmospheric pressure (14.7 pounds) to various gauge pressures.

Two-Stage Compression

Initial Temperature of Air Taken as 60 degrees F.—Jackson-Cooling Not Considered.

Gauge Pressure Pounds	Absolute Pressure Pounds	No. of Atmospheres	Correct Ratio of Cylinder Volumes	Inter-cooler Gauge Pressure	ISOTHERMAL COMPRESSION		ADIABATIC COMPRESSION				Percentage of Saving over One-stage Comp
					Mean Eff. Pressure	H. P.	Mean Eff. Pressure Theoretical	Mean Eff. Pressure plus 15% Friction	H. P. Theoretical	H. P. plus 15% Friction	
50	64.7	4.40	2 10	16.2	21.80	0.095	24.30	27.90	0.106	0.123	10.9
60	74.7	5.08	2.25	18.4	23.90	0.104	27.20	31.30	0.118	0.136	11.3
70	84.7	5.76	2.40	20.6	25.70	0.112	29.31	33.71	0.128	0.147	12.3
80	94.7	6.44	2.54	22.7	27.52	0.120	31.44	36.15	0.137	0.158	13.8
90	104.7	7.12	2.67	24.5	28.93	0.126	33.37	38.36	0.145	0.167	14.2
100	114.7	7.80	2.79	26.3	30.30	0.132	35.20	40.48	0.153	0.176	15.0
110	124.7	8.48	2.91	28.1	31.42	0.137	36.82	42.34	0.161	0.185	15.2
120	134.7	9.16	3.03	29.8	32.60	0.142	38.44	44.20	0.168	0.193	15.6
130	144.7	9.84	3.14	31.5	33.75	0.147	39.86	45.83	0.174	0.200	16.3
140	154.7	10.52	3.24	32.9	34.67	0.151	41.28	47.47	0.180	0.207	16.7
150	164.7	11.20	3.35	34.5	35.59	0.155	42.60	48.99	0.186	0.214	16.9
160	174.7	11.88	3.45	36.1	36.30	0.158	43.82	50.39	0.191	0.219	18.4
170	184.7	12.56	3.54	37.3	37.20	0.162	44.93	51.66	0.196	0.225	19.0
180	194.7	13.24	3.64	38.8	38.10	0.166	46.05	52.95	0.201	0.231	19.3
190	204.7	13.92	3.73	40 1	38.80	0.169	47.16	54.22	0.206	0.236	19.5
200	214.7	14.60	3.82	41.4	39.50	0.172	48.18	55.39	0.210	0.241	20.1
210	224 7	15.28	3.91	42.8	40.10	0.174	49.35	56.70	0.216	0.247	
220	234.7	15.96	3.99	44.0	40.70	0.177	50.30	57.70	0.220	0.252	
230	244.7	16.64	4.08	45.3	41.30	0.180	51.30	59.10	0.224	0.257	
240	254.7	17.32	4.17	46.6	41.90	0.183	52.25	60.10	0.228	0.262	
250	264.7	18.00	4.24	47.6	42.70	0.186	52.84	60.76	0.230	0.264	
260	274.7	18.68	4.32	48.8	43.00	0.188	53.85	62.05	0.235	0.270	
270	284.7	19.36	4.40	50.0	43.50	0.190	54.60	62.90	0.238	0.274	
280	294.7	20.04	4.48	51.1	44.00	0.192	55.50	63.85	0.242	0.278	
290	304.7	20.72	4.55	52.2	44.50	0.194	56.20	64.75	0.246	0.282	
300	314.7	21.40	4.63	53.4	45.30	0.197	56.70	65.20	0.247	0.283	
350	364.7	24.80	4.98	58.5	47.30	0.206	60.15	69.16	0.262	0.301	
400	414.7	28.20	5.31	63.3	49.20	0:214	63.19	72.65	0.276	0.317	
450	464.7	31.60	5.61	67.8	51.20	0.223	65.93	75.81	0.287	0.329	
500	514.7	35.01	5.91	72.1	52.70	0.229	68.46	78.72	0.298	0.342	

Horse-Power Required

For compressing one cubic foot of free air per minute (isothermally and adiabatically) from atmospheric pressure (14.7 pounds) to various gauge pressures.

Three-Stage Compression

Initial Temperature of Air Taken as 60 degrees F.—Jacket-Cooling Not Considered.

Gauge Pressure Pounds	Absolute Pressure Pounds	No. of Atmospheres	Correct Ratio of Cylinder Volumes	INTERCOOLER GAUGE PRESSURES		ISOTHERMAL COMPRESSION		ADIABATIC COMPRESSION				Percentage Saving over 2-Stage Comp.
				First Stage	Second Stage	Mean Eff. Pressure	H. P	Mean Eff. Pressure Theoretical	Mean Effective Pressure plus 15% Friction	H. P. Theoretical	H. P. plus 15% Friction	
100	114.7	7.8	1.98	14.4	42.9	30.30	0.132	33.30	38.30	0.145	0.167	5.23
150	164.7	11.2	2.24	18.2	59.0	35.59	0.155	40.30	46.50	0.175	0.202	5.92
200	214.7	14.6	2.44	21.2	73.0	39.50	0.172	45.20	52.00	0.196	0.226	6.67
250	264.7	18.0	2.62	23.8	86.1	42.70	0.186	49.20	56.60	0.214	0.246	6.96
300	314.7	21.4	2.78	26.1	98 7	45.30	0.197	52.70	60.70	0.229	0.264	7.28
350	364.7	24.8	2.92	28.2	110.5	47.30	0.206	55.45	63.80	0.242	0.277	7.64
400	414.7	28.2	3.04	30.0	121.0	49.20	0.214	58.25	66.90	0.253	0.292	8.33
450	464.7	31.6	3.16	31.8	132.3	51.20	0.223	60.40	69.40	0 263	0.302	8.36
500	514.7	35.0	3.27	33.4	142.4	52.70	0.229	62.30	71.70	0.273	0 314	8.38
550	564.7	38.4	3.38	35.0	153.1	53.75	0.234	65.00	74.75	0.283	0 326	8.80
600	614.7	41.8	3.47	36.3	162.3	54.85	0.239	66.85	76.90	0.291	0.334	8.86
650	664.7	45.2	3.56	37.6	171.5	56.00	0.244	67.90	78.15	0.296	0.340	9.02
700	714.7	48.6	3.65	38.9	180.8	57.15	0.249	69.40	79.85	0.303	0.348	9.18
750	764 7	52.0	3.73	40.1	189.8	58.10	0.253	70.75	81.40	0.309	0.355	
800	814.7	55.4	3.82	41.4	199.5	59.00	0.257	72.45	83.25	0.315	0.362	
850	864 7	58.8	3.89	42.5	207.8	60.20	0.262	73.75	84:90	0.321	0.369	
900	914.7	62.2	3.95	43.4	214 6	60 80	0.265	74.80	86.00	0.326	0.375	
950	964.7	65.6	4.03	44.6	224.5	61.72	0.269	76.10	87.50	0.331	0.381	
1000	1014.7	69.0	4.11	45.7	233.3	62.40	0.272	77.20	88.80	0.336	0 383	
1050	1064.7	72.4	4:15	46.3	238.3	63.10	0.275	78.10	90.10	0.340	0 391	
1100	1114.7	75.8	4.23	47.5	248.3	63.80	0.278	79.10	91.10	0.344	0.396	
1150	1164.7	79.2	4.30	48.5	256.8	64 40	0.281	80.15	92.20	0.349	0 401	
1200	1214.7	82.6	4.33	49.0	261.3	65.00	0.283	81.00	93.15	0.353	0 405	
1250	1264.7	86.0	4.42	50.3	272.3	65.60	0.286	82.00	94.30	0 357	0.411	
1300	1314.7	89.4	4.48	51.3	280.8	66 30	0.289	82.90	95.30	0 362	0.416	
1350	1364.7	92.8	4.53	52.0	287.3	66.70	0.291	84.00	96.60	0.366	0.421	
1400	1414.7	96.2	4.58	52.6	293.5	67 00	0 292	84 60	97.30	0 368	0.423	
1450	1464.7	99.6	4.64	53 5	301.5	67.70	0.295	85.30	98.20	0 371	0.426	
1500	1514.7	103.0	4.69	54 3	309.3	68 30	0.298	85 80	98.80	0 374	0.430	
1550	1564.7	106.4	4.74	55.0	317.3	68.80	0.300	86.80	99.85	0.378	0.434	
1600	1614.7	109.8	4.79	55.8	323.3	69.10	0.302	87.60	100.80	0.382	0.438	

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Loss of Pressure in Compressed Air Transmission

The following tables give the drop in pressure per 1,000 feet of pipe, for different deliveries, and pipe sizes from 1 to 16 inch.

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Delivery in Cu. Ft. of Compressed Air per Min.	Equiv. Delivery in Cu. Ft. of Free Air per Min.	Size of Pipe, Inches																	
		1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	16
		Loss of Pressure, in Pounds, by Friction in 1000 Feet Lengths of Pipe																	
At 60 Pounds Gauge																			
9.84	50	18.24	5.06	1.95	.42	.13	.05												
14.73	75		11.34	4.33	.95	.29	.11	.05											
19.64	100		20.16	7.79	1.69	.52	.19	.08	.04										
24.60	125			12.23	2.65	.81	.30	.13	.07	.03									
29.45	150			17.53	3.80	1.16	.44	.19	.09	.05	.03								
34.44	175				5.17	1.58	.59	.26	.13	.07	.04	.01							
39.35	200				6.77	2.09	.78	.36	.17	.09	.06	.02	.01						
49.20	250				10.61	3.24	1.22	.55	.27	.15	.08	.03	.01						
58.90	300				15.20	4.65	1.78	.78	.38	.21	.12	.05	.02	.01					
68.6	350					6.31	2.37	1.07	.53	.29	.17	.06	.03	.01					
78.6	400					8.28	3.11	1.40	.69	.39	.22	.08	.04	.01					
88.4	450					10.47	3.94	1.77	.88	.48	.28	.11	.05	.02	.01				
98.4	500						4.88	2.20	1.08	.60	.34	.14	.06	.03	.01				
118.1	600						7.03	3.17	1.56	.87	.49	19	.09	.04	.02	.01			
137.5	700						9.52	4.29	2.12	1.17	.67	.27	.12	.06	.03	.02			
156.6	800							5.57	2.75	1.52	.87	.34	.15	.08	.04	.03	.01		
176.5	900							7.08	3.49	1.94	1.17	.43	.19	.09	.05	.03	.01		
196.4	1000							8.77	4.33	2.40	1.37	.54	.24	.12	.06	.04	.02	.01	
294.5	1500								9.73	5.39	3.08	1.20	.55	.27	.15	.09	.03	.01	
393.7	2000									9.65	5.51	2.16	.98	.41	.27	.16	.06	.03	.01
492	2500										8.61	3.36	1.53	.77	.42	.25	.09	.04	.02
589	3000											4.82	2.19	1.11	.61	.36	.14	.06	.03
686	3500											6.54	2.97	1.50	.83	.48	.19	.09	.04
786	4000												3.91	1.98	1.08	.63	.25	.11	.05
884	4500												4.94	2.51	1.36	.79	.32	.15	.07
984	5000												6.19	3.10	1.69	.99	.39	.18	.09
At 80 Pounds Gauge																			
7.74	50	14.31	3.96	1.53	.33	.10	.03	.01											
11.3	75		8.46	3.26	.71	.21	.08	.03	.01										
15.2	100		15.31	5.92	1.28	.39	.14	.06	.03	.02	.01								
19.4	125			9.64	2.09	.64	.24	.11	.05	.03	.01								
23.2	150			13.79	2.99	.91	.34	.15	.07	.04	.02	.01							
27.2	175				4.09	1.25	.47	.21	.10	.06	.03	.01							
31.0	200				5.34	1.63	.61	.27	.13	.07	.04	.01							
38.7	250				8.32	2.54	.96	.43	.21	.12	.07	.02	.01						
46.5	300				12.01	3.67	1.38	.62	.30	.17	.09	.03	.01						
54.2	350					4.99	1.88	.84	.41	.23	.13	.05	.02	.01					
62.0	400					6.53	2.45	1.11	.54	.30	.17	.06	.03	.01					
69.7	450					8.25	3.13	1.40	.69	.38	.22	.08	.04	.01					
77.4	500					10.81	3.83	1.73	.85	.47	.27	.10	.05	.02	.01				
92.9	600						5.61	2.46	1.22	.68	.39	.15	.06	.03	.02	.01			
108.2	700						7.46	3.37	1.66	.92	.53	.20	.09	.04	.02	.01			
124.0	800						9.86	4.42	2.18	1.19	.69	.27	.12	.06	.03	.02	.01		
139.5	900							5.61	2.77	1.54	.88	.34	.15	.08	.04	.02	.01		
152	1000							6.64	3.29	1.82	1.04	.40	.18	.09	.05	.03	.01		
232	1500							15.41	7.62	4.24	2.43	.95	.43	.22	.12	.06	.02	.01	
310	2000								13.62	7.58	4.32	1.69	.77	.39	.21	.12	.04	.02	.01
387	2500									11.79	6.88	2.64	1.19	.60	.33	.19	.07	.03	.01
465	3000										9.72	3.79	1.73	.87	.48	.28	.11	.05	.02
542	3500										13 25	5.27	2.35	1.19	.65	.37	.15	.06	.03
620	4000											6.78	3.07	1.55	.85	.49	.19	.09	.04
697	4500											8.54	3.89	1.97	1.08	.66	.25	.11	.05
774	5000											10.55	4.79	2.46	1.33	.77	.30	.14	.07

For longer or shorter pipes the friction loss is proportional to the length, *i.e.*, for 500 feet ½ of the above; for 4,000 feet four times the above, etc.

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Delivery in Cu. Ft. of Compressed Air per Min.	Equiv. Delivery in Cu. Ft. of Free Air per Min.	Size of Pipe, Inches																	
		1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	16
		Loss of Pressure, in Pounds, by Friction in 1000 Feet Lengths of Pipe																	
At 100 Pounds Gauge																			
6.41	50	11.89	3.29	1.28	.27	.08	.03	.01											
9.61	75		7 42	2.87	.62	.19	.07	.03	.01										
12 81	100		13.20	5.11	1.15	.34	.12	.05	.02	.01									
15.81	125			7.75	1.68	.52	.19	.08	.04	.02	.01								
19.22	150			11.42	2.48	.76	.29	.13	.06	.03	.02	.01							
22.39	175				3.36	1.03	.39	.17	.09	.04	03	.01							
25.62	200				4.43	1.36	.51	.23	.12	.06	.04	.02	.01						
31.62	250				6.72	2.06	.77	.35	.17	.09	.05	.02	.01						
38.44	300				9.95	3.04	1.14	.51	.25	.14	.08	.03	.01						
44.78	350				13.41	4.11	1.54	.69	.34	.19	.11	.04	.02	.01					
51.24	400					5.40	2.06	.92	.45	.25	.15	.05	.03	.01					
57.65	450					6.85	2.57	1.16	.57	.32	.18	.07	.03	.02	.01				
63.24	500					8.21	3.08	1.39	.68	.38	.22	.08	.04	.02	.01				
76.88	600					12.21	4.58	2.14	1.03	.57	.33	.12	.05	.03	.02	.01			
89.56	700						6.19	2.79	1.38	.77	.44	.17	.07	.04	.02	.01			
102.5	800						8.13	3.67	1.81	1.00	.57	.22	.10	.05	.03	.02	.01		
115.3	900						10.23	4.64	2.29	1.27	.76	.28	.13	.06	.04	.02	.01		
126.5	1000						12.39	5.00	2.76	1.23	.88	.34	.16	.08	.04	.03	.01		
192.2	1500							12.81	6.68	3.51	2.03	.78	.36	.18	.09	.05	.02	.01	
256.2	2000								11.35	6.61	3.62	1.41	.67	.33	.18	.10	.04	.02	.01
316.2	2500									9.50	5.51	2.14	.97	.49	.27	.16	.06	.03	.01
384.4	3000									14.04	8.11	3.16	1.44	.76	.39	.23	.19	.04	.02
447.8	3500										10.95	4.26	1.93	.98	.53	.31	.12	.05	.03
512.4	4000										14.48	5.59	2.55	1.30	.72	.41	.16	.07	.04
576.5	4500											7.04	3.22	1.84	.89	.52	.21	.09	.05
632.4	5000											8.51	3.88	1.93	1.07	.63	.25	.11	.08
At 125 Pounds Gauge																			
5.26	50	9.88	2.70	1.05	.23	.07	.03	.01											
7.89	75	22.20	6.07	2.37	.51	.16	.06	.03	.01										
10.51	100	39.50	10.82	4.22	.91	.28	.10	.05	.02	.01									
13.15	125		16.88	6.58	1.42	.43	.16	.07	.04	.02	.01								
15.79	150		24.33	9.47	2.04	.63	.23	.11	.05	.03	.02	.01							
18.41	175		33.05	12.90	2.78	.85	.32	.14	.07	.04	.02	.01							
21.05	200			16.84	3.63	1.11	.42	.19	.09	.05	.03	.01							
26.30	250			26.30	5.68	1.73	.65	.29	.15	.08	.05	.02	.01						
31.58	300			37.90	8.18	2.51	.94	.42	.21	.12	.07	.03	.01						
36.81	350				11.08	3.39	1.27	.58	.28	.16	.09	.04	.02	.01					
42.10	400				14.51	4.44	1.67	.75	.37	.21	.12	.05	.02	.01					
47.30	450				18.38	5.61	2.11	.95	.47	.26	.15	.06	.03	.01	.01				
52.60	500				22.68	6.95	2.61	1.18	.58	.32	.18	.07	.03	.02	.01				
63.20	600					10.00	3.76	1.69	.84	.46	.27	.10	.05	.02	.01	.01			
73.70	700					13.60	5.11	2.31	1.14	.63	.36	.14	.06	.03	.02	.01			
84.20	800					17.80	6.68	3.01	1.49	.83	.47	.18	.08	.04	.02	.01	.01		
94.70	900						8.45	3.81	1.88	1.04	.60	.23	.11	.05	.03	.02	.01		
105.1	1000						10.42	4.71	2.32	1.29	.74	.29	.13	.07	.04	.02	.01		
157.9	1500						23.48	10.59	5.23	2.90	1.65	.64	.29	.15	.08	.05	.02	.01	
210.5	2000							18.81	9.30	5.15	2.94	1.15	.52	.26	.15	.08	.03	.02	.01
263.0	2500							29.40	14.52	8.05	4.60	1.80	.82	.41	.23	.13	.05	.02	.01
315.8	3000								20.90	11.59	6.63	2.59	1.18	.60	.33	.19	.07	.03	.02
368.1	3500								28.51	15.78	9.01	3.53	1.61	.81	.45	.26	.10	.04	.02
422.0	4000									20.61	11.80	4.61	2.19	1.06	.58	.34	.13	.06	.03
473.0	4500									26.10	14.90	5.83	2.65	1.34	.73	.43	.17	.08	.04
526.0	5000									32.20	18.45	7.20	3.27	1.65	.90	.53	.21	.10	.05

For longer or shorter pipes the friction loss is proportional to the length, *i.e.*, for 500 feet ½ of the above; for 4,000 feet four times the above, etc.

DISCHARGE OF AIR THROUGH AN ORIFICE

IN CUBIC FEET OF FREE AIR PER MINUTE

Flowing From a Round Hole in Receiver Into the Atmosphere

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Receiver Gauge Pressure Pounds	Diameter of Orifice													
	1/64 inch	1/32 inch	1/16 inch	1/8 inch	1/4 inch	3/8 inch	1/2 inch	5/8 inch	3/4 inch	7/8 inch	1 inch	1 1/4 inch	1 1/2 inch	2 inch
	Discharge in Cubic Feet of Free Air per Minute													
2	038	.153	.647	2.435	9.74	21.95	39.	61	87.60	119.50	156	242.	350.	625.
5	.0597	.242	965	3.86	15.40	34.60	61.60	96 50	133.	189.	247.	384.	550.	985.
10	.0842	.342	.136	5.45	21.8	49.	87	136.	196	267	350	543.	780.	....
15	103	.418	1.67	6.65	26.70	60.	107.	167	240	326	427	665.	960.	....
20	119	.485	1.93	7.7	30.8	69	123	193	277	378	494	770.	....	....
25	.133	.54	2.16	8.6	34.5	77	138	216	310	422	550.	860.	....	....
30	.156	.632	2.52	10.	40	90	161	252	362.	493	645	1000.	....	....
35	.173	.71	2.80	11.2	44 7	100	179	280	400	550.	715	....	....	....
40	.19	.77	3.07	12.27	49 09	110 45	196 35	306.80	441 79	601.32	785.40	....	....	....
45	.208	.843	3.36	13.4	53.8	121	215	336	482.	658.	860	....	....	....
50	.225	.914	3.64	14 50	58.2	130.	232	364.	522	710.	930.	....	....	....
60	.26	1.05	4.2	16.8	67	151	268	420	604.	622	....	....	....	....
70	.295	1.19	4.76	19.	76.	171.	304.	476.	685.	930.	....	....	....	....
80	33	1 33	5.32	21.2	85.	191	340	532	765.	1004.	....	....	....	....
90	.364	1.47	5.87	23.50	94	211	376.	587	843.	....	....	....	....	....
100	40	1 61	6.45	25.8	103.	231.	412	645	925	....	....	....	....	....
125	.486	1.97	7.85	31.4	125.	282.	502	785	....	....	....	....	....	....

Cubic Feet of Free Air

Required to Run One Drill of Size and at the Pressure Stated Below.

Gauge Pressure Lbs	Cylinder Diameter of Drill												
	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/8"	3 3/16"	3 1/4"	3 1/2"	3 5/8"	4 1/4"	5"	5 1/2"
60	50	60	68	82	90	95	97	100	108	113	130	150	164
70	56	68	77	93	102	108	110	113	124	129	147	170	181
80	63	76	86	104	114	120	123	127	131	143	164	190	207
90	70	84	95	115	126	133	136	141	152	159	182	210	230
100	77	92	104	126	138	146	149	154	166	174	199	240	252

Multipliers to Determine Capacity of Compressor

Required to Operate from 1 to 70 Rock Drills at Altitudes Compared with Sea Level

Altitude Above Sea Level Feet	Number of Drills																		
	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	40	50	60	70
	Multipliers																		
0	1.	1.8	2.7	3.4	4.1	4.8	5.4	6.0	6.5	7.1	8.1	9.5	11.7	13.7	15.8	21.4	25.5	29.4	33.2
1000	1.03	1.85	2.78	3.5	4.22	4.94	5.56	6.18	6.69	7.3	8.34	9.78	12.05	14.1	16.3	22.0	26.26	30 3	34.2
2000	1.07	1.92	2.89	3.64	4.39	5.14	5.78	6.42	6.95	7.60	8.67	10.17	12.52	14 66	16.9	22.9	27.28	31.46	35.52
3000	1.10	1.98	2.97	3.74	4.51	5.28	5.94	6.6	7.15	7.81	8.91	10.45	12.87	15.07	17.38	23.54	28.05	32.34	36.52
4000	1.14	2.05	3.08	3.88	4.67	5.47	6 15	6.84	7.41	8.09	9.23	10.83	13.34	15.62	18.01	24.4	29.07	33 52	37.8
5000	1.17	2.10	3.16	3.98	4.8	5.62	6 32	7.02	7.61	8 31	9.48	11.12	13.69	16.03	18.49	25.04	29.84	34.4	38.84
6000	1.20	2.16	3.24	4.08	4.9	5.76	6.48	7.2	7.8	8.52	9.72	11.4	14.04	16.44	18.96	25.68	30.6	35.4	39.84
7000	1.23	2 21	3.32	4.18	5.04	5.9	6.64	7.38	7 99	8.73	9.96	11.68	14.39	16 85	19.43	26.32	31.36	36.16	40.84
8000	1.26	2.27	3.40	4.28	5.17	6.05	6.8	7.56	8 19	8.95	10.21	11.97	14.74	17.26	19.9	29.96	32.13	37.04	41.83
9000	1.29	2.32	3.48	4.39	5.29	6.19	6 96	7.74	8.38	9.16	10.45	12.26	15.09	17 67	20.38	27.6	32.9	37.92	42.83
10000	1.32	2.38	3.56	4.49	5.41	6.34	7.13	7.92	8.58	9.37	10.69	12.54	15.44	18.08	20.86	28.25	33.66	38.8	43.82
12000	1.37	2.47	3.70	4.66	5.62	6.57	7.4	8 22	8 9	9.73	11.1	13.02	16.03	18.77	21 64	29.32	34.94	40.28	45.48
15000	1.43	2.57	3.86	4.86	5.86	6.86	7.72	8.58	9.3	10.15	11.58	13.58	16.73	19.59	22.59	30.6	36.46	42.04	47.47

EXAMPLE—Required the amount of free air necessary to operate thirty 5-inch drills at 9,000 feet altitude, using to operate these drills air at a gauge pressure of 80 pounds per square inch.

From Table above we find, when operating the drills at 80 pounds gauge pressure at sea level, that one 5-inch drill requires 190 cubic feet of free air per minute.

From Table opposite we also find that the factor for 30 drills at 9.000 feet altitude is 20.38; multiplying 190 cubic feet by 20.38 gives 3,872 cubic feet free air per minute, which is the displacement of a compressor for the above outfit under average conditions, to which must be added pipe line losses, such as friction and leakage

Mechanical, Electrical and Heat Equivalents

1 H. P. =
- 746 watts.
- 0.746 K. W.
- 33,000 ft.-lbs. per minute.
- 550 ft.-lbs. per second.
- 2,545 heat-units per hour.
- 42.4 heat-units per minute.
- 0.707 heat unit per second.
- 0.175 lb. carbon oxidized per hour.
- 2.64 lbs. water evaporated per hour from and at 212° F.

1 Kilowatt =
- 1,000 watts
- 1.34 horse-power.
- 2,654,200 ft.-lbs. per hour.
- 44,240 ft.-lbs. per minute.
- 737.3 ft.-lbs. per second.
- 3,412 heat-units per hour.
- 56.9 heat-units per minute.
- 0.948 heat-unit per second.
- 0.2275 lb. carbon oxidized per hour.
- 3.53 lbs. water evaporated per hour from and at 212° F.

1 Watt =
- 1 joule per second.
- 0.00134 H. P.
- 3.412 heat-units per hour.
- 0.7373 ft.-lb. per second.
- 0.0055 lb. water evaporated per hour.
- 44.24 ft.-lbs. per minute.

1 H. P. Hour =
- 0.746 K. W. hours.
- 1,980,000 ft.-lbs.
- 2,545 heat-units.
- 273,740 k. g. m.
- 0.175 lb. carbon oxidized with perfect efficiency.
- 2.64 lbs. water evaporated from and at 212° F.
- 17.0 lbs. water raised from 62° F. to 212° F.

1 K. W. Hour =
- 1,000 watt hours.
- 1.34 horse-power hours.
- 2,654,200 ft.-lbs.
- 3,600,000 joules.
- 3,412 heat units.
- 367,000 kilogram meters.
- 0.235 lb. carbon oxidized with perfect efficiency.
- 3.53 lbs. water evaporated from and at 212° F.
- 22.75 lbs. of water raised from 62° to 212° F.

1 Ft-lb. =
- 1,356 joules.
- 0.1383 k. g. m.
- 0.000000377 K. W. hours.
- 0.001285 heat-units.
- 0.0000005 H. P. hour.

Horse Power of Double Acting, Single Cylinder Steam Engines:

$$HP = \frac{P \times L \times A \times N \times F}{33000}$$

P = Gauge pressure at engine.
L = Length of stroke in feet.
A = Area of piston in square in.
N = Number of strokes per min.
F = Factor of cut-off.
 = .599 for ¼ cut-off.
 = .670 for 1-3 cut off.

HORSE POWER DEVELOPED TO COMPRESS 100 CUBIC FEET FREE AIR FROM ATMOSPHERE TO VARIOUS PRESSURES

Gauge pressure, pounds	One-stage compression D. H. P.	Gauge pressure, pounds	ASSUMING PERFECT COOLING BETWEEN STAGES		
			Two-stage compression D. H. P.	Three-stage compression D. H. P.	Four-stage compression D. H. P.
5	1.96	60	11.70	11.20	10.80
10	3.60	70	12.70	12.00	11.70
15	5.03	80	13.70	13.00	12.50
20	6.28	90	14.70	14.00	13.50
25	7.42	100	15.40	14.50	14.20
30	8.47	125	17.50	16.00	15.60
35	9.42	150	19.00	17.50	16.70
40	10.30	200	21.20	19.50	18.75
45	11.14	300	24.50	22.90	21.80
50	11.90	400	27.70	25.70	24.00
55	12.67	500	29.75	27.60	25.90
60	13.41	600	31.70	29.20	27.50
70	14.72	700	33.50	30.60	28.90
75	15.37	800	34.90	31.80	30.00
80	15.94	900	36.30	32.90	31.00
85	16.50	1000	37.80	33.80	31.80
90	17.06	1200	39.70	35.50	33.30
100	18.15	1400	41.60	36.80	34.60
150	24.00	1600	43.00	38.10	35.65
200	26.20	1800	44.50	39.30	36.70
400	36.00	2000	45.50	40.60	37.80
...	.....	2500	.....	.....	39.06
...	.....	3000	.....	.....	40.15

An addition of 10 to 15 per cent. should be made for friction and intake temperature higher than 60 degrees Fahrenheit, on which this table is based. Atmospheric pressure is assumed at 14.7 pounds per square inch. No account taken of jacket cooling.

Courtsey H. K. Porter Co.

THE BROWNELL COMPANY.

DAYTON, OHIO.

Manufacturers of

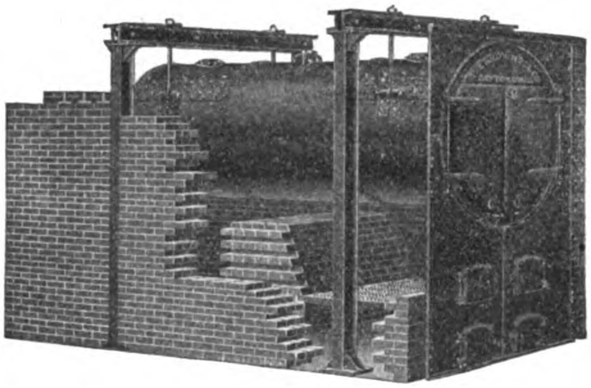
Engines, Boilers & Feed Water Heaters

Products

Horizontal Return Tubular Boilers; Scotch Internally Fired Boilers; Locomotive Type Boilers; Portable Boilers; Vertical Tubular Boilers; Quickset Heating Boilers; Feed Water Heaters; High Speed Automatic Engines; Throttling Engines; Duplex Variable Speed Engines; Brownell Self Oiling Fan Engines; Steel Boiler Casings; Boiler Fronts; Breechings; Grate Bars; etc.

Horizontal Return Tubular Boilers

Brownell Horizontal Return Tubular Boilers are built according to the specifications of the Association of American Steel Manufacturers. All steel used for heads, shell, straps, must conform to these specifications, and thicknesses, laps, etc., are computed with a safety factor of five. Seams are butt-jointed with a double strap, and are double, triple, or quadruple riveted according to the size and pressure to be carried.

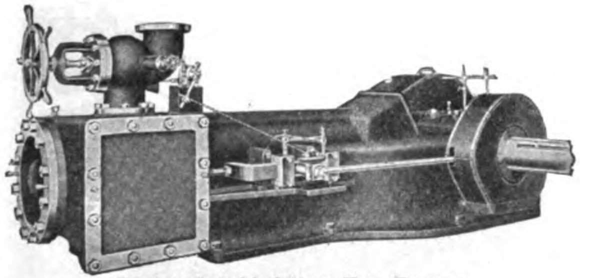


Horizontal Return Tubular Boiler, Bricked In, Suspended or Gallows Frame Setting.

Brownell Horizontal Return Tubular Boilers are built in sizes from 15 to 250 horse power, and for working pressures from 100 to 150 pounds, or for lower pressures for heating purposes.

Enclosed Self Oiling Fan Engine

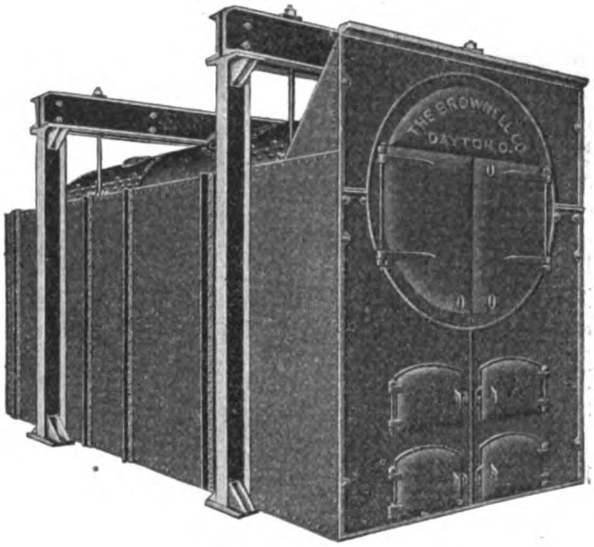
The cross head guides are circular in shape, are cast solid with the cylinder and are bored at the same time, insuring alignment. The main bearing is of the quarter box type adjustable for wear, carefully machined, and grooved to insure perfect distribution of the oil. The lubricating system is that known as the splash system. The lower edge of the crank disc runs in a bath of oil which it splashes up into the guide barrel and into auxiliary reservoirs, from which it is carried to all working parts and drained back by gravity.



Enclosed Self Oiling Fan Engine
60 to 300 H. P.

Steel Casing Setting

The steel boiler casing consists of a sheet steel casing which entirely surrounds the brickwork. The casing is put together and stiffened with angle braces, and bolted to the I-beam columns which support the boiler.

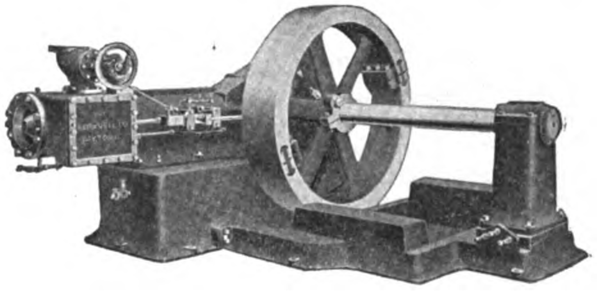


Horizontal Return Tubular Boiler. Standard Box Type Steel Casing Setting.

The use of the steel boiler setting eliminates the losses due to imperfections in the brick setting, decreases the radiation losses, and permits the use of higher draft pressures. The cost of the sheet steel setting is very little if any more than the regular brick setting, and readily demonstrates its superiority.

Brownell High Speed Automatic Engines

This engine is of the side crank type, with the flywheel between the bearings. The flywheel is of the best grade grey cast iron, strong enough to stand the operating stresses. The automatic governor is enclosed in the flywheel. The governor is of the Rites Inertia Flywheel type, guaranteed to regulate the speed of the engine within 2% from friction load to full load.



Enclosed Self Oiling Automatic Engine
60 to 320 H. P.

The main bearing is of the quarter box type, with the bottom box removable without disturbing the shaft. The outer bearing is of the flat box type, adjustable in any direction while the engine is running, and oiled by a chain. The lubrication of the parts of the engine other than the outer bearing is by the splash system.

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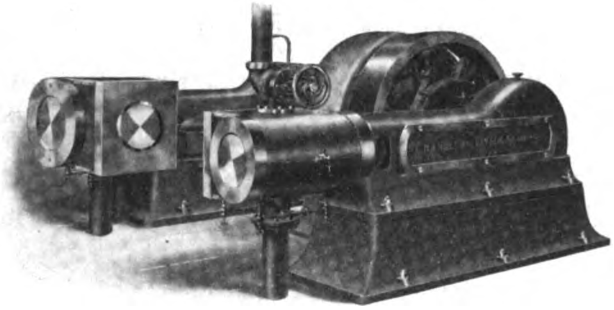
Single Direct Connected, 25 to 300 K. W.
Tandem Compound, 25 to 300 K. W.
Cross Compound, 50 to 500 K. W.

Fan Engines

Open and Enclosed types from 15 to 500 H. P. Speeds 300 to 175 R. P. M. With or without Hand Cut Off Device.

Our large line of types and sizes permits us to select engines for any steam pressure, any degree of superheat, and for any speed which your particular conditiions might require.



Cross Compound.

Our Piston Valves give wonderful economy over long periods, because they stay steam tight. See guarantee below.

Direct Connected Engines

Simple, Tandem and Cross Compound Engines are all Enclosed and Self Oiling.

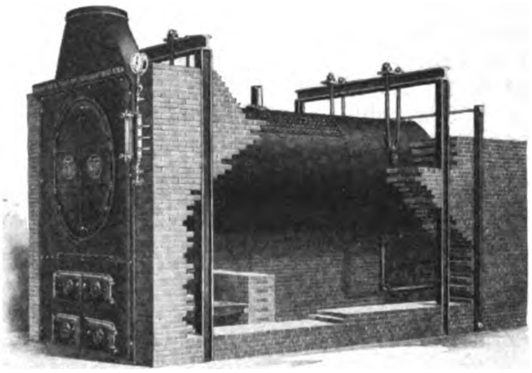
These are all made to fit any of the standard Electric Generators on the market.

We guarantee our Valves to operate steam tight for five years.

Steam Boilers

Stationary Tubular, 15 to 250 H. P.
Pressures, 100 to 150 lbs.
Carried in stock.
Set Singly or in Batteries.
With or without Steel Casings.
Fronts to fit any Standard Stokers.
Dutch Oven Settings.
Breechings.
Stacks.

Firebox Boilers



Boiler In Brick Setting.

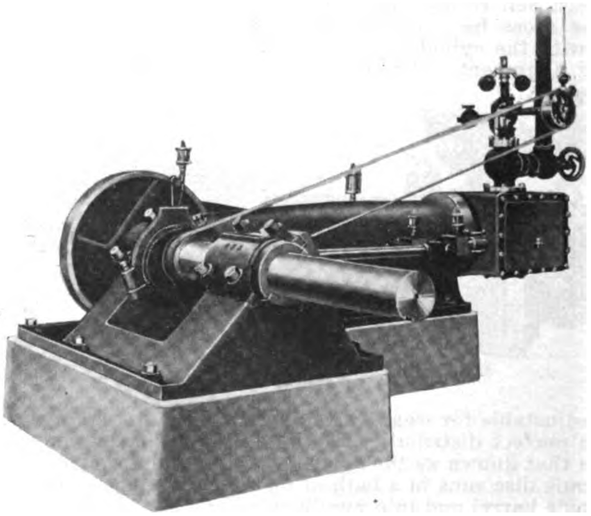
Boilers

Are all built with a factor of safety of five and contain tubes made by the "Spellerized Process," which U. S. Government reports show, are better than tubes made of charcoal iron.

This is a distinct advantage in boilers used in Mine Service. Some of the biggest operators are using our tubes.

Fan Engines

Are made with Hand Cut-Off Device when desired, and of either the Open or Enclosed type.



Open Type Fan Engine.

ERIE CITY IRON WORKS

Manufacturers of

Steam Engines, Boilers and Feed Water Heaters

Main Office and Works

ERIE, PA.

Products

Erie City Vertical and Horizontal Water Tube Boilers; Improved "Economic" Boilers; Horizontal Return Tubular Boilers; Portable Boilers.

Erie City High Speed Engines; "Lentz" Engines; Throttling and Four-Valve Engines.

Erie City "Counter Current" Feed Water Heaters; Shaking Grates; Tanks, Steel Stacks, etc.

Erie City Vertical Water Tube Boiler

This boiler is composed of two horizontal drums—one placed directly above the other and connected by a series of tubes, the whole being supported by a heavy frame of steel because a wall of masonry surrounds the boiler, and a frontal extension, lined with fire brick and forced with a metal front, forms the furnace.

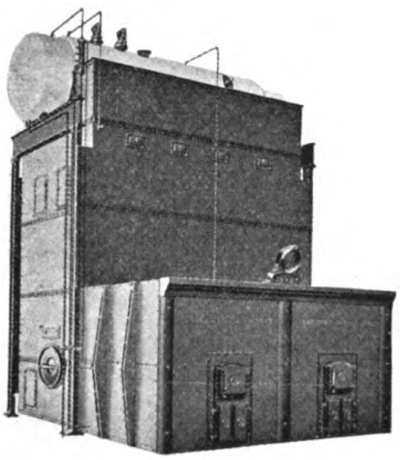
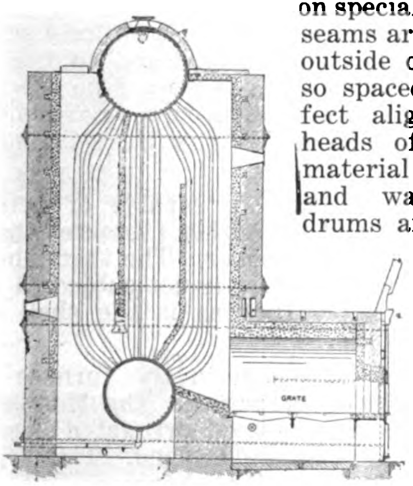


Fig. 1—Erie City Vertical Water Tube Boiler.

General Construction

Shell Plates are rolled to a true circle, longitudinal seams are double butt strapped; edges of plate are bevel planed; end of top strip is scarfed on special milling machines; seams are calked inside and outside of shell; tubes are so spaced as to leave perfect alignment of metal; heads of drums of same material as shell; steam and water openings in drums are reinforced with pressed steel nozzles, and flanges are thoroughly riveted and calked.



The tubes are curved to permit expansion and contraction. Spaces between different banks of tubes permit a man to enter. Each tube enters drum radially. Tubes are easily cleaned by air or hydraulic cleaner.

Erie City "Economic" Return Tubular Boiler

Shell and heads made of open hearth homogeneous steel; tubes and rivets, of mild steel. Boiler is self-contained, occupies small space and is a rapid steamer. Deep water surrounds furnace on two sides. No stay-bolted water sides to fill with mud and burn out, or flat crown sheets to be exposed by low water and cause explosions and loss of life. Front and sides of furnace are lined with 9 ins. of fire brick, with air space on outside wall next to steel casing (Figs. 4 and 5).

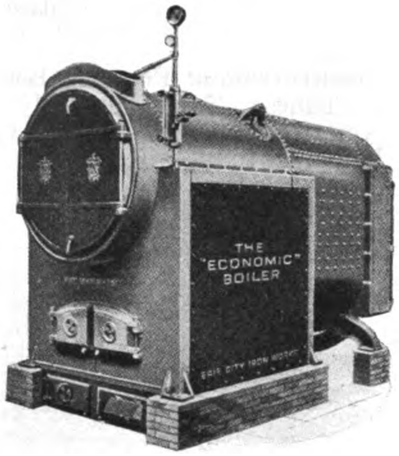


Fig. 3—"Economic" Return Tubular Boiler.
Regularly built for 100 lbs. working pressure, and for higher pressures on order.

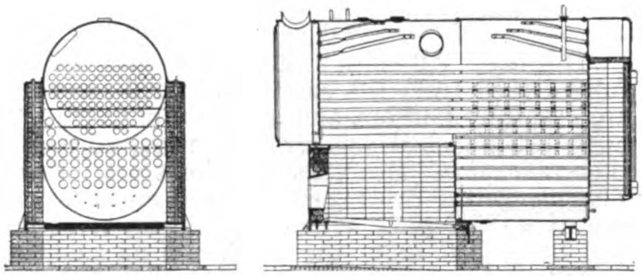
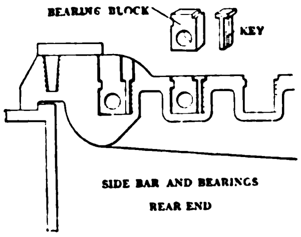


Fig. 4—Sectional View of "Economic" Boiler.
Protected by patents.

Erie City Shaking Grates

Grates properly proportioned for majority of fuels used under steam boilers. Note bearing blocks in side bars and how held in place. Blocks and keys carefully fitted together.



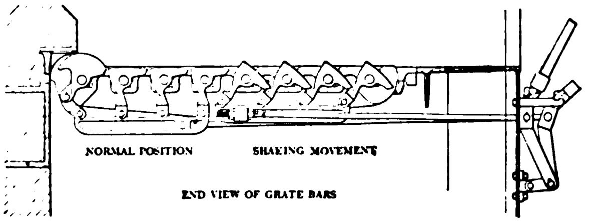


Fig. 5—Sectional View of Grates.

Worn bearing readily replaced, insteal of renewing entire horizontal side bar. Individual bars designed to prevent loss of fuel through grates to ash pit while in shaking position. Note normal position and shaking movement.

FREEMAN MANUFACTURING CO.

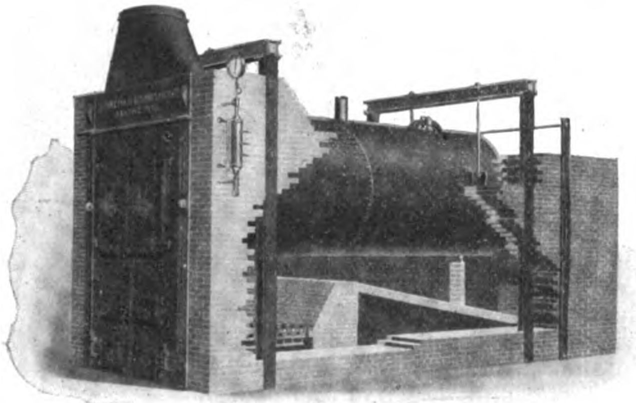
Chicago Office---Monadnock Building
MAIN OFFICE--RACINE, WISCONSIN

Manufacturers of

Horizontal Return Tubular Boilers; Scotch Internally Fired Marine Type Boilers; Water Tube Boilers; Water Jackets; Steel Tanks: Self Supporting Steel Stacks; Smoke Connections; Grate Bars; Stand Pipes; Riveted Steel Pipe; All Kinds of Steel Plate Work.

Construction of Freeman Boilers

Tubes: Tubes regularly supplied are the best American lap welded steel. Charcoal iron or seamless steel tubes will be furnished when specified.



Freeman High Pressure Tubular Boiler with Full Flush Front and Gallows Frame Suspension.

Drilling: All holes in heads for tubes are carefully **drilled** from the solid plate. All rivet holes are carefully laid out and are then punched. The holes are punched smaller than required and are then reamed in place after the shells are rolled up. This brings the holes perfectly true, and avoids the use of a drift pin. When so ordered, rivet holes will be drilled from the solid, for an additional charge.

Material: Homegeneous open hearth steel plates are used, each sheet bearing the name of the maker, the brand, and the tensile strength. All materials entering into the construction of Freeman boilers, such as plates, heads, tubes, rivets and braces will conform to the standard adopted by the **American Society of Mechanical Engineers.**

Supports: The method of support shown above is entirely independent of the walls. All Horizontal Return Tube Boilers have two hangers on each side for attaching suspension rods. The supporting rods are attached to a channel beam supported by I-beam columns. The whole system of support is amply strong on every part and properly arranged to allow for expansion and contraction without injury to the brick work. Lug Hung Boilers also furnished.

Test

We subject all boilers to a hydrostatic test pressure 50 per cent in excess of the working pressure for which they are constructed. We furnish without extra charge a certificate of such test when so requested. We will also furnish a policy of insurance in any of the reliable boiler insurance companies at cost.

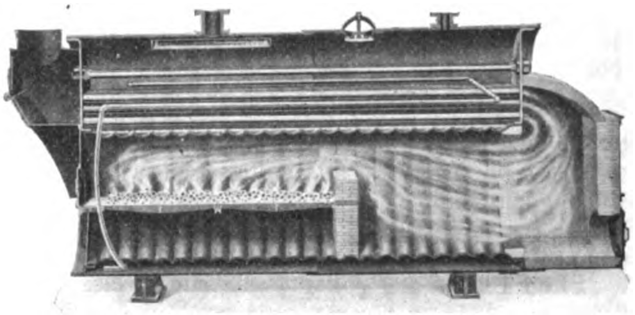
Return Tubular Boilers

Freeman Return Tubular Boilers are constructed to meet the requirements of the laws of the states in which they may go. Our boilers are all made to order, hence greater care is given in their construction. Advise us as to the horsepower and pressure you require and we will be glad at any time to send you setting plan, specifications and prices.

Internally Fired Boilers

This type of boiler is designed to do away with exterior brick work, and to save room in their setting. The elimination of the brick work saves the heat absorbed by the walls and radiated from them. They are economical in space requiring less room in length and breadth than any other type of high pressure boiler.

The internally fired boiler of this type is the most compact and efficient boiler designed. Its efficiency is due to the fact that it is entirely self-contained. All the heat generated is applied directly to the heating surface and there are no cracks to allow cold air to enter the furnace. Expansion and contraction take place freely, without damage to the foundation or support.



Sectional View, Showing Freeman Boiler with Morison Furnace.

Internally fired boilers are capable of being made in larger sizes and for higher pressures than any other type of fire tube boiler. The thick shell required for the high pressure is not subjected to the extremes of temperature as is the shell of Return Tubular Boilers.

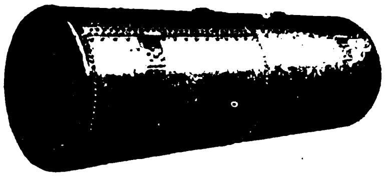
Contraction and expansion in the furnace is taken care of by the construction. The Morrison Corrugated furnaces are made of corrugated sheets which are free to contract and expand. This type is seen in the illustration. The Adamson Expansion Ring type consists of short section with wide flanges, the flanges being riveted near the outer edge, thus allowing a large movement.

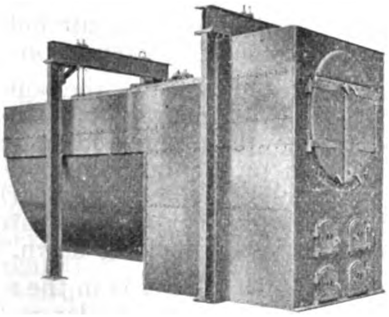
The Houston, Stanwood & Gamble Co.

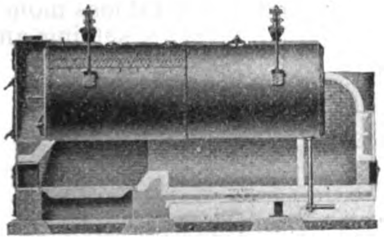
CINCINNATI, OHIO

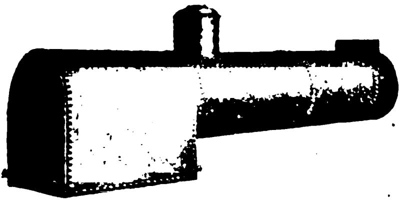
Products

Horizontal Tubular Boilers, Steel Casing Boiler Settings, Locomotive Fire Box Boilers, Feed Water Heaters, Stacks, Heavy Tanks, Grate Bars, Boiler Castings, Steam Engines, both of shaft governor and throttling governor types, and of both open and enclosed, automatically oiling types; Hoisting Engines, Fan Engines, Haulage Engines, Screen Engines, Dynamo Engines.


High Pressure, Butt Joint H. T. Boiler.


Steel Casing Setting for H. T. Boiler.


Sectional View of Steel Casing Setting.


High Pressure Locomotive Fire Box Boiler.

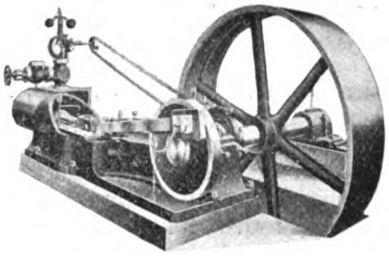
Horizontal Tubular Boilers are built in all sizes up to 84 x 20-250 H. P., the most popular sizes, taking both first cost per H. P. and operating efficiency into consideration, being the 72-inch, 78-inch and 84-inch diameters in the 18 and 20 feet lengths. The American Society of Mechanical Engineers' Boiler Code Specifications are recommended by us to prospective purchasers. The moderate extra cost of boilers built to these specifications is more than justified by the greater safety and durability of the A. S. M. E. code boiler.

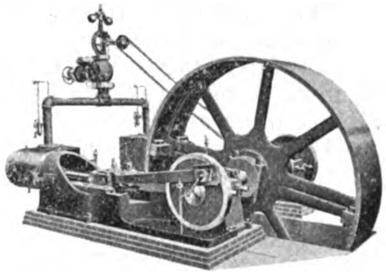
Our Steel Casing Setting with the Catenary-shaped combustion chamber is an efficient design of the steel casing setting, which it is generally recognized, avoids setting repairs, also saves coal through almost eliminating the leakage of air into the setting. We build steel casings in a wide variety of designs and have installations in almost every locality.

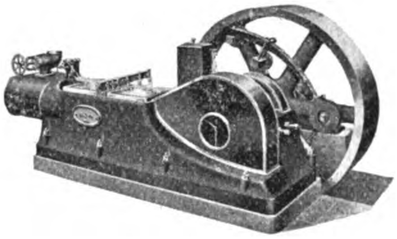
In addition to the open type Feed Water Heater illustrated, we build a number of designs of closed heaters.

Our enclosed type engine is built with shaft governor, with throttling governor, also with hand adjustable variable cut-off, and as all parts, even the valve gear, are completely enclosed, is particularly well suited to coal mine service. It is used for fans, dynamos, and general power service in sizes from 60 to 300 H. P. Our open type engines are used for all kinds of service for which the enclosed engines are employed, also have been used frequently for driving crushers, shaking screens, haulage equipment, for hoisting, etc., etc.

"Universal" Improved Open Feed Water Heater, Purifier, Filter and Oil Separator.


Heavy Duty Side Crank Throttling Engine.


Twin Engine for Haulage or for General Power Purposes.


Completely Enclosed, Automatically Oiling, Shaft Governor Engine for Belted Dynamo Drive or for General Power Purposes.

ESTABLISHED 1864

E. KEELER COMPANY

WILLIAMSPORT, PA.

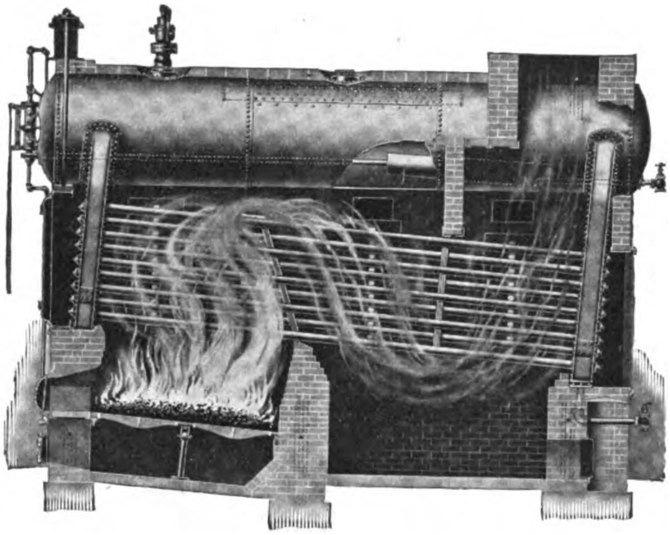
NEW YORK BOSTON PHILADELPHIA PITTSBURGH RICHMOND, VA. CHICAGO

MANUFACTURERS OF

Water Tube and Return Tubular Boilers, Stacks, Etc.

Keeler Water Tube Boilers

Built in units from sixty to twelve hundred fifty horse power, wrought steel construction througout. Straight tubes, horizontal drums, vertical baffle walls, rear casing.



Every portion of the heating surface is accessible for both external and internal inspection, making it impossible for soot or scale to accumulate undetected. Special side cleaning doors make it possible to observe the condition of the outside surface of the tubes. There is no part of the internal surface that cannot be examined and cleaned.

The facility with which a straight tube is cleaned and, if necessary, replaced is only one of its obvious advantages. When the water contains scale-forming substances the use of a straight tube is almost imperative.

The superior efficiency of the Keeler Boiler rests upon correct proportion of heating and grate surface for the character of fuel to be burned, ample height of furnace, superior arrangement of baffle walls and a perfect circulation.

Our Water Tube Boilers are in use by the United States Government (five thousand horse power being used on the Panama Canal), Pennsylvania R. R. Co., New York Central R. R. Co., Buffalo, Rochester & Pittsburg R. R. Co., and in many Pennsylvania, West Virginia and Ohio coal mines.

It is cheaper to invest a trifle extra in first cost rather than to inherit later repair bills.

For fifty-three years we have been building boilers, during that time our shop has never been shut down, and we have never known of a Keeler Boiler exploding.

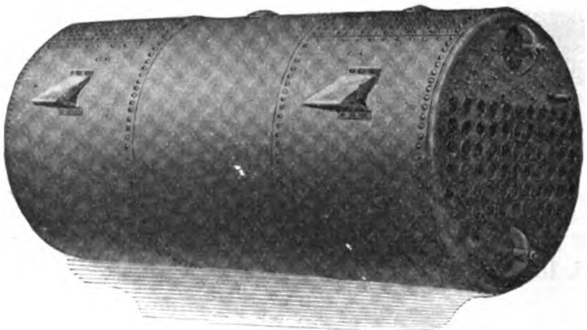
Our new illustrated catalogue furnished on request.

Keeler Return Tubual Boilers

Have a reputation for high quality of fifty-two years' growth. Rivet holes are made 3-16" small and after boiler plates are assembled the holes are drilled to size. This insures perfect alignment. All burs are removed before riveting, tube holes are drilled from the solid plate and not punched small and reamed to size. The holes are slightly countersunk on the outside. This eliminates the possibility of the sharp edge cutting the tube when beading it. All seams are thoroughly caulked on the outside, and the ends of butt straps are caulked on the inside. All plates are full thickness on the edge and not ordered to weight. Braces are drop forged; trimmings, including steam-outlets, man-hole plates, yokes and brackets, are all of pressed steel. Besides being stronger than cast iron they are of known quality. Cast iron is unsatisfactory for pressure parts; it frequently has sand or air holes which cannot be detected by surface inspection.

A steam separator is located inside of the boiler shell at the steam outlet. This insures dry steam and prevents water entering steam pipe and engine cylinder. An internal feed pipe enters the boiler through the front head at one side, extends nearly the length of the shell, crosses over to the center and discharges through an elbow looking down.

The chief difference in boilers today is in the attention given to details. This is why one boiler costs more than another where specifications are practically the same. The cost of the boiler itself is a small part of your total cost. A cheaply constructed tubular boiler may have to be removed in a short time and you will have to charge off as a total loss money spent for freight, hauling, labor, brick setting and stack erection. The amount of money saved in buying what is known as a competition boiler generally proves to be an unwarranted risk. A Keeler boiler will never be anything but the best that our resources and fifty-three years of experience can produce.



Ask for our book—"Boiler Facts."

UNION IRON WORKS,

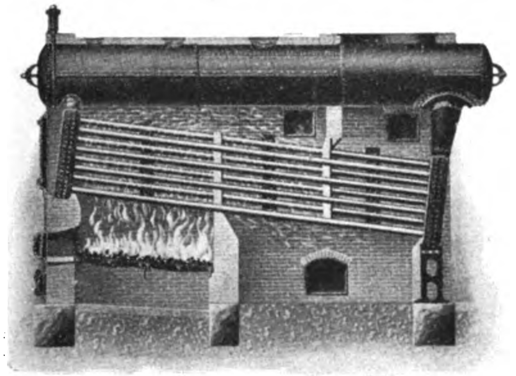
Cascade Street, ERIE, PA.

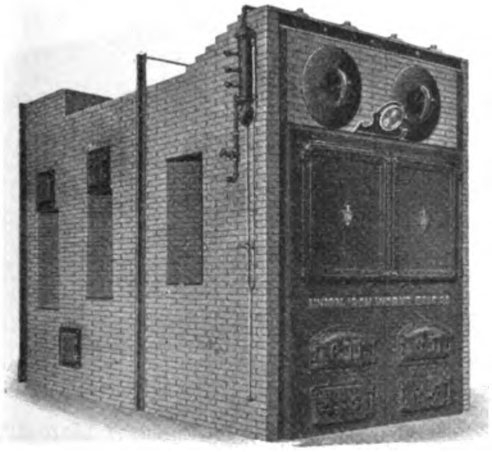
MANUFACTURERS OF STEAM BOILERS.

Branch Offices: Cleveland, New York, Pittsburgh, Philadelphia.

Union Water Tube Boilers

Union Water Tube Boilers are the result of 27 years boiler making experience, they are the true Horizontal Water Tube type, every square foot of heating surface is really effective heating surface. All of the tubes are up-flowing members, having greater inclination than is usually found. The drums are horizontal giving ample water storage and steam liberating surface. The connection from drums to the headers is made by a patented Union corrugated flange, giving ample area for unrestricted circulation as well as flexibility which absorbs the destructive distortion due to unequal expansion so injurious to rigid headed boilers. There are no throat braces in the drums to retard circulation. Our patented purifier in the rear of the drum entirely out of the path and fire of circulation is a real depository for impurities in the feed water. The headers are of ample depth and at no point have two thicknesses of plate or rivets exposed to the fire. The staybolt pitch is regular in all directions, giving the strongest header made. The tube pitch is vertically staggered with horizontal spacing to provide for a thorough cleaning and inspection while in service. Standard baffling is the vertical type, but horizontal baffling may be used where desired. Union Boilers will take any standard superheater for stoker equipment without alterations.





Distinctive Features

No other boiler on the market today has so many features of advantage incorporated in its design as the Union Water Tube Boiler.

1st. Horizontal Drums—liberating surface, dry steam, water storage capacity.

2nd. Purifier in drums, settling chamber out of fire and circulating element, provided with reinforced blowoff connection.

3rd. Corrugated flange connection from drums to headers, no restricted area, good circulation, relieving boiler of internal strains.

4th. Headers made in integral halves in one heat, of ample depth, no double plates or rivets exposed to fire, regular, not irregular pitch of staybolts. Shape of handhole, easily kept tight. Additional blowoff bottom of headers.

5th. Handhole plates of steel plate each removable through hole it covers, no fishing, yoke of novel design, quickly removed.

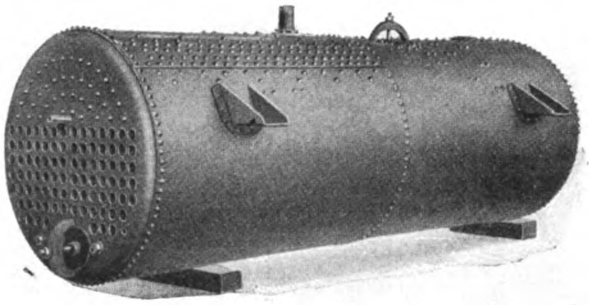
6th. Greater inclination of tubes promoting circulation, vertically staggered, horizontal spacing to permit proper cleaning on fire side. Ample gas passage areas.

7th. The very best workmanship that can be done by a well trained organization and modern facilities.

8th. Continued operating efficiency and greater overload capacity than any other boiler, due to the combination of these features, resulting in less time required to clean boiler when necessary, longer period of continued efficient operation, minimum loss of time out of service.

Union Return Tubular Boilers

For working pressure 100 to 150 pounds. Built in sizes up to 225 Horse-power. Constructed in strict accordance with any special state laws, and under the inspection of the Hartford Steam Boiler and Insurance Company. Specially adapted for coal mine use and widely known throughout the coal regions. Send for list of installations by coal companies, amounting to over one thousand boilers, which should be sufficient assurance of the quality and reliability of "Union" Boilers. Practically all of these boilers are 72"x18" return tubulars.



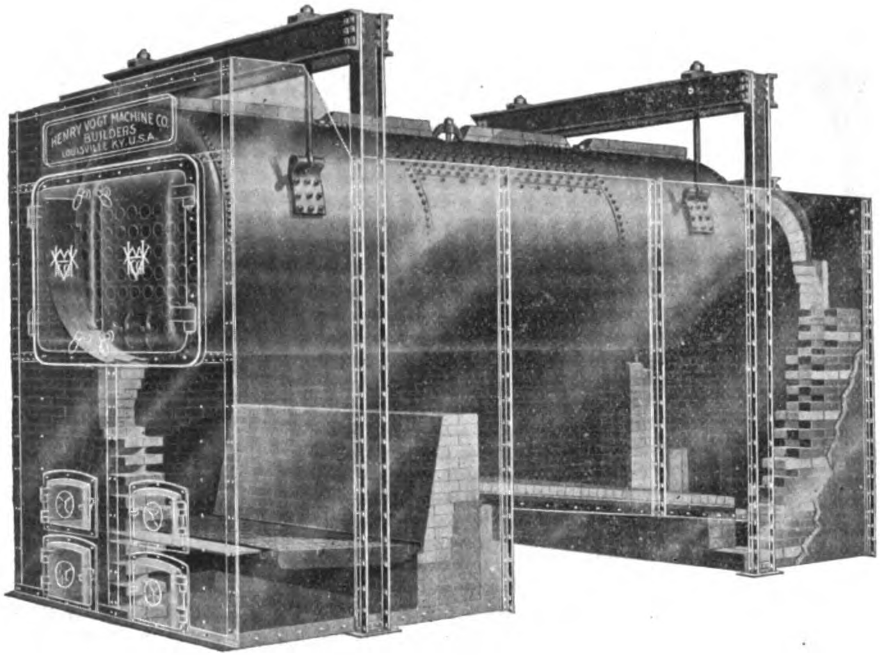
HENRY VOGT MACHINE CO.

INCORPORATED

LOUISVILLE, KY

Manufacturers of

Water Tube and Horizontal Return Tubular Boilers

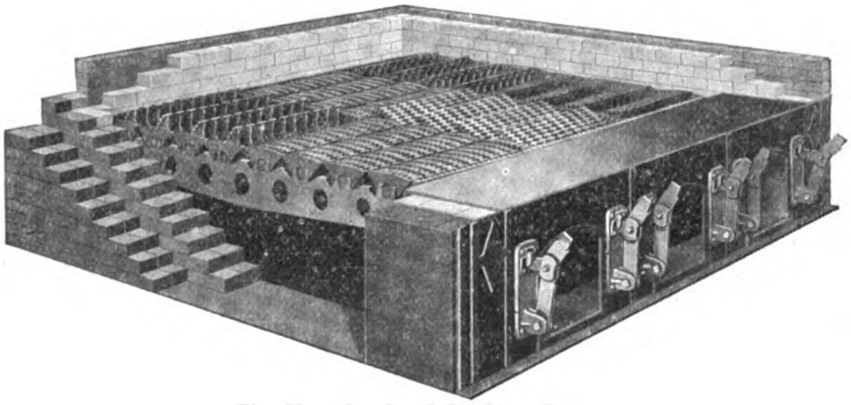

HENRY VOGT MACHINE CO.
BUILDERS
LOUISVILLE, KY. U.S.A.

The Vogt Sectional Steel Casing.

PRODUCTS

- Water Tube and Horizontal Return Tubular Boilers.
- Ice and Refrigerating Machinery.
- Drop Forgings.
- Grey Iron Castings.
- Plate and Sheet Metal Work, Etc.

An ideal combination for the coal mine power plant.
Vogt Horizontal Return Tubular Boilers equipped with Sectional Steel Casings and Rocking Grates.
High efficiency at low maintenance cost.



The Vogt Sectional Rocking Grates.

The Walsh & Weidner Boiler Company

CHATTANOOGA, TENN

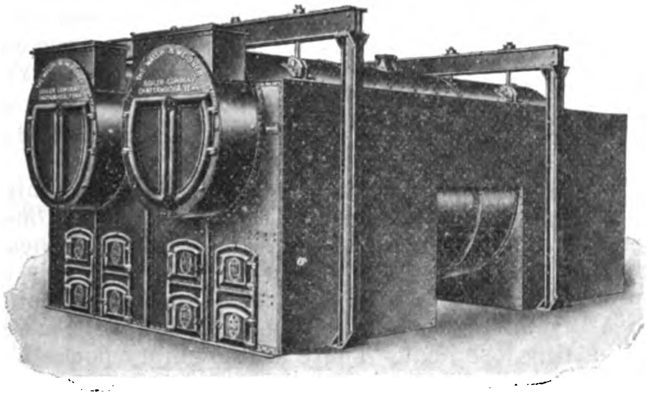
Manufacturers of

Boilers, Structural Steel Work, Tanks and Towers, Pressure Tanks, Stacks and Sheet Iron Work

We Carry a Large Stock of Boiler Tubes, Steel Plate, Rivets, Pipe, Fittings, Grate Bars and Boiler Castings.

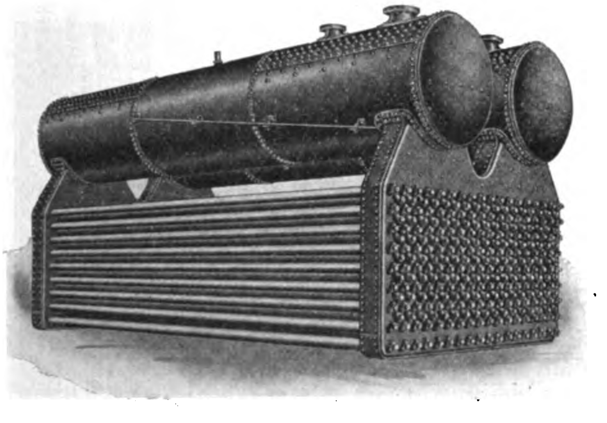
Products

We can furnish **Horizontal Return Tubular Boilers,** water tube, marine type with Morrison Corrugated or Adamson Ring Type furnaces, Portable, Vertical and Locomotive type boilers.



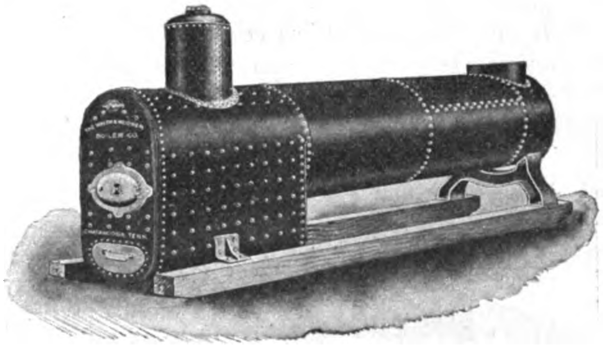
The Walsh & Weidner Improved Steel Casing for Horizontal Return Tubular Boilers.

Steel Casings are now being used almost universally in the installation of horizontal return tubular boilers. They offer many advantages, minimum floor space, low cost of maintenance, portability and fuel economy. Can be furnished for single boiler or batteries of any number of boilers.



The Walsh & Weidner Water Tube Boiler.

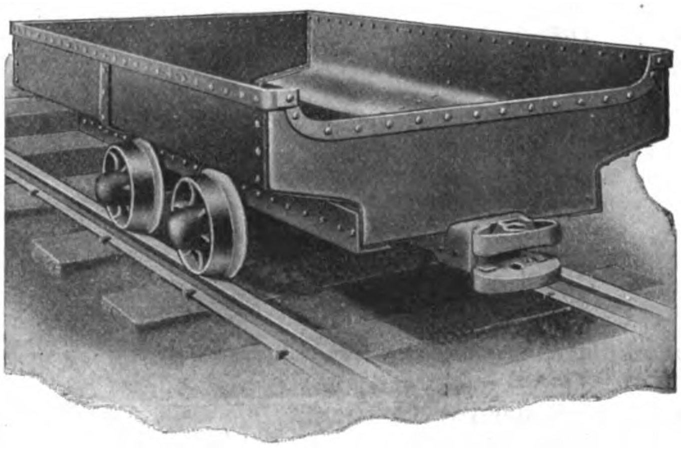
Horizontal **Water Tube Boilers** can be furnished in sizes from 75 to 500 H. P., in working pressures from 100 to 250 pounds. They are equipped with a very efficient mud and scale device, have a very large throat area, which guarantees perfect circulation, can be equipped with any form of automatic stoker, and is especially suitable for restricted spaces, such as office buildings and hotel basements. They are of all steel construction.



Water Front Portable Boiler.

Our **Portable Boilers** are made in working pressures of 100, 125 and 150 lbs. We make them water front and water bottom, or water front and open bottom. We are prepared to build these boilers on quick notice and make prompt shipment. They are built in accordance with the Hartford Steam Boiler Ins. & Inc. Co.'s requirements.

We illustrate below **Coal Mine Car** which we are prepared to build and ship promptly. These cars have special corrugated steel bottom with continuous drawn beams under the bottom, thereby preventing the same from buckling. They are made of heavy steel plate furnished with any style wheels, and are one of the best styles of Coal Cars on the market.



Special Corrugated Bottom Steel Car.

THE WICKES BOILER CO.

Main Office and Works:
SAGINAW, MICHIGAN
SALES OFFICES IN PRINCIPAL CITIES.

Manufacturers of Steam Boilers

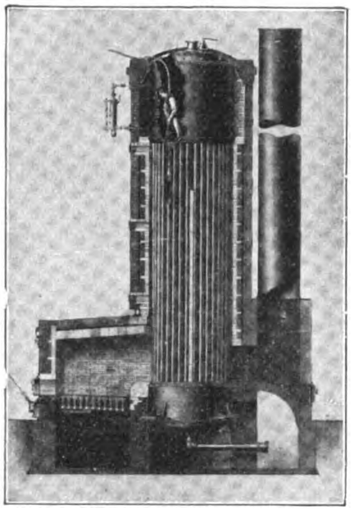
Wickes Vertical Water Tube Boilers and Steel Cased Boiler Settings

---

Products

The Wickes Vertical Water Tube Boilers.

Water Tube Boilers have proved their efficiency. The Wickes Vertical Water Tube Boiler has proven its superiority. First: It is constructed entirely of homogeneous material and uses straight tubes. Second: It operates with high commercial efficiency—the sum of all efficiencies.



Ask the Man Who CLEANS One.

A commercially efficient boiler is one which develops the greatest number of boiler horsepower hours per year with the highest thermal efficiency, while delivering the driest steam.

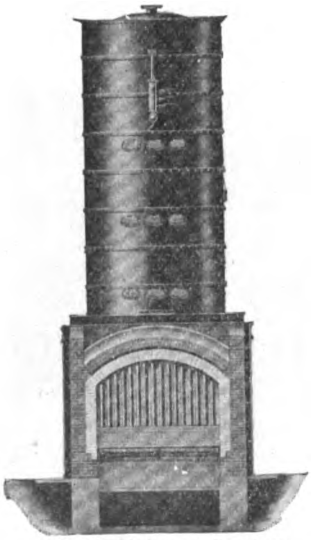
Cleaning and repairs cause boilers to stand idle. This lost time reduces its commercial efficiency. Therefore, that boiler is best which:

1st. Is so accessible that it can be cleaned in the shortest possible time.

2nd. Is simple, has few parts, and whose water circulation is so perfect as to maintain equal temperature in all parts of structure; hence, is durable; hence, free from repairs.

3rd. Prevents low furnace temperature, gas short circuiting and air infiltration. These are the enemy to high thermal efficiency.

4th. Delivers dry steam, hence prevents consuming unnecessary water, causing low engine and turbine efficiency and mechanical breakage.



The Steel Cased Setting.

Accessibility and Cleaning

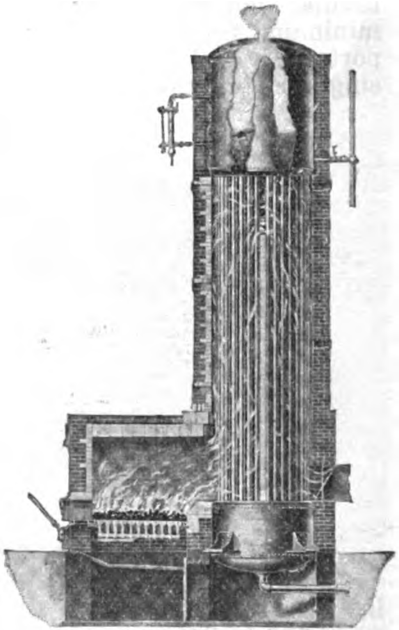
In the Wickes Vertical Tube Boiler two 11x15 inch manholes open in this boiler—one top—one bottom—inspection and cleaning is a simplified matter. Every tube can be looked through, washed or scraped. A boiler easy and quick to clean is likely to be cleaned often and well, that is human nature. If you have ever cleaned a boiler and lamed your back, bruised your knees, and skinned your elbows doing it you will appreciate the accessible construction of this vertical boiler at a glance. Two men can open, turbine and close this boiler in ten hours. You know how long it takes to clean some boilers.

Thermal Efficiency.

In The Wickes Vertical Water Tube Boiler high furnace temperature results from Dutch oven. Gases entirely and closely surround, therefore, scrub heating surface from entrance to release. There is no possible chance for short circuiting. The boiler heating surface absorbs the heat—empty pockets in setting lose heat. There are no empty pockets in this boiler. The steel cased settings are always tight, no cracked, warped, leaky, defective and unsightly settings exist with this type. A steel cased setting is a simple and sure cure for air infiltration losses. The largest preventable losses we have to contend with in boiler efficiency are excess air losses. A very long gas travel—hence long contact with heating surface is provided. Heat absorption is, therefore, assured.

High Steam Quality.

Did you ever wreck an engine by pulling water into it from boiler? Study this boiler. The steam drum gives great height from water line to steam outlet nozzle. This height provides room for separation of the steam from the water which is entrained with it at a point close to the surface of liberation. You do not pull water into engine from this boiler. Steam turbines receiving steam from this boiler never have their nozzles or blades eroded or filled up with matter carried over from boiler.



Quick Steaming Delivering Dry Steam.

THE ENGINEER COMPANY

NEW YORK

(Balanced Draft)

The Turner Baffle Wall

Products

Balanced Draft, a system of efficient combustion.

The Turner Baffle Wall, a permanant gas tight boiler baffle.

Balanced Draft saves fuel and increases boiler output.

Balanced Draft is a system of combustion which insures the admission of the correct amount of air for all rates of fuel consumption.

The Apparatus

The apparatus comprises a sensitive but strong furnace pressure regulator which operates the flue damper and the blast gate, and controls the speed of the stoker, if one is used, as may be necessary.

Draft

The correct draft depends upon the fuel used, the boiler design and the firing conditions; and when the regulator is set for the point of highest efficiency, it constantly maintains it.

Under these conditions, the percentage of CO_2 is increased, the stack temperatures are lowered, the efficiency of the heating surface is greater and the capacity of the stack increased.

Positive pressure above the fire which is so destructive to furnace linings, grates, stokers and fronts is impossible with Balanced Draft and further, the firemen are protected from flame blasts through firing or observation doors.

Application

Balanced Draft is used with all kinds of fuel, including coal, coke breeze, oil and gas, and can be applied to heating furnaces as well as to steam boilers.

Two million horse power of boilers are now using Balanced Draft—effecting an annual saving of over 750,000 tons of coal. These plants are supervised by Modern Engineers demanding high boiler ratings and efficiencies.

Service

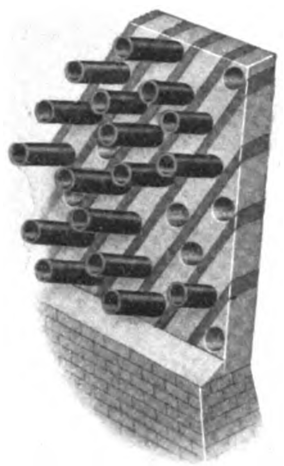
We will be glad to assist you in solving your combustion problems.

Tight Boiler Baffles

Every one interested in Steam Plants knows the importance of tight baffles, the difficulty in making them tight and keeping them tight.

Composition or poured cement walls have not been a success, while brick laid against flame plates are easily knocked out, resulting in leaks which cause loss of heat and high stack temperatures.

The Turner Baffle Wall is built tight and stays tight.



The Turner Baffle Wall is composed of fire brick laid as diagonal shelves on the boiler tubes; the poskets formed by the tubes and the tile being completely filled with a fire resisting cement in a plastic condition.

The plastic cement in setting, shrinks away from the tubes so that a cold tube may be easily pulled out and renewed without injuring the wall. The expansion of the tube when hot closes this space and makes the wall tight.

Bent tubes can be replaced with straight tubes, and the enlarged hole closed with the plastic cement, by boiler room force.

In case of accident, the wall is easily repaired.

The baffle can be built sloping forward or backward at any angle, and the best from of pass secured.

It is self-supporting; no flame plates are needed.

Turner Walls will not crumble; walls built four years ago are still sound and tight.

Estimates furnished on old and new boilers.

Combustion Engineering Corporation

11 Broadway
NEW YORK CITY

Owners and Manufacturers of

Type "E" Stoker---For Bituminous Coal
The Grieve Grate---For All Hand-Fired Fuels

Sole Representatives

Coxe Traveling Grate Co. **The Automatic Anthracite and Coke Breeze Stoker**

PHILADELPHIA, PA. HAZLETON, PA. PITTSBURGH, PA. BOSTON, MASS. CHICAGO, ILL. MINNEAPOLIS, MINN. SALT LAKE CITY, UTAH BIRMINGHAM, ALA.

Products

Type "E" underfeed stokers for bituminous coals.

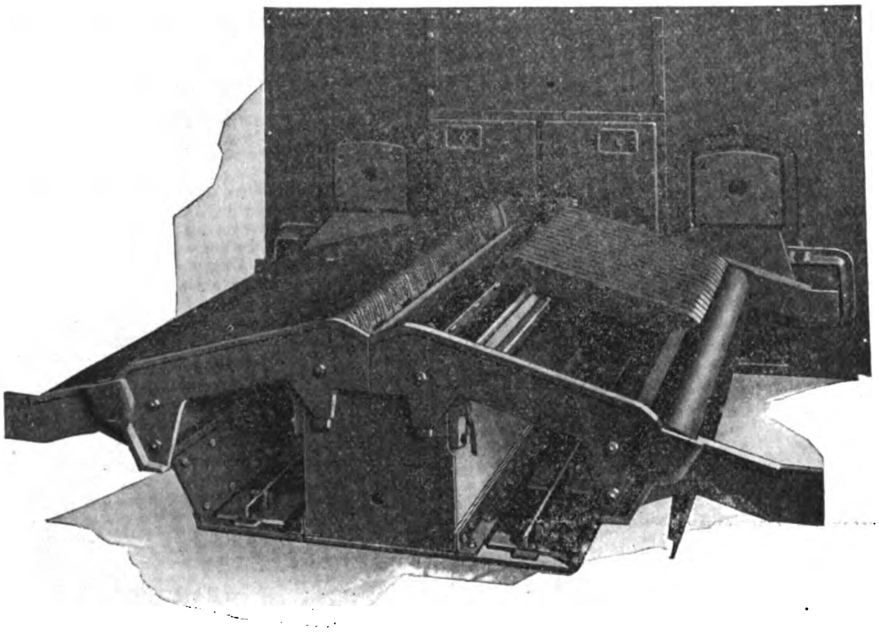
Coxe stokers for anthracite coal and coke breeze.

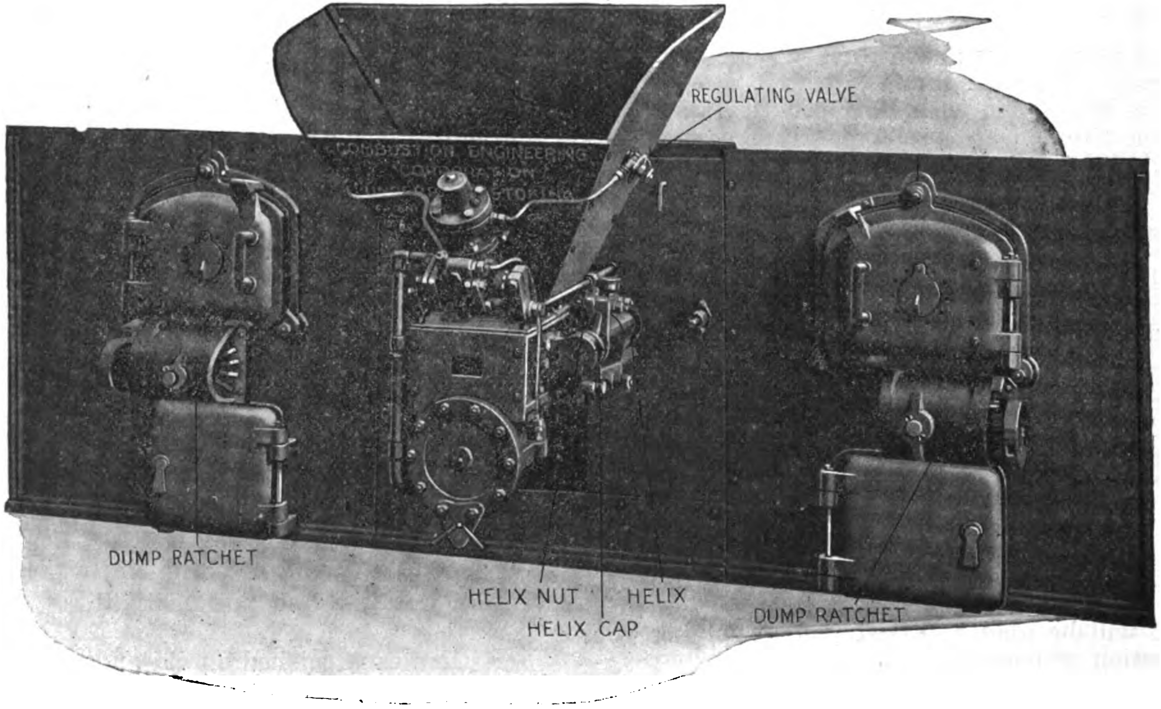
Grieve grates—Shaking, dumping and stationary.

Type "H" stokers for Industrial and Metallurgical heating furnaces of all kinds.

Upper cut shows rear elevation Type "E" Stoker with bars on one side removed showing the extreme simplicity of construction and operation.

Lower cut shows front elevation of stoker. Note the absence of complicated parts.

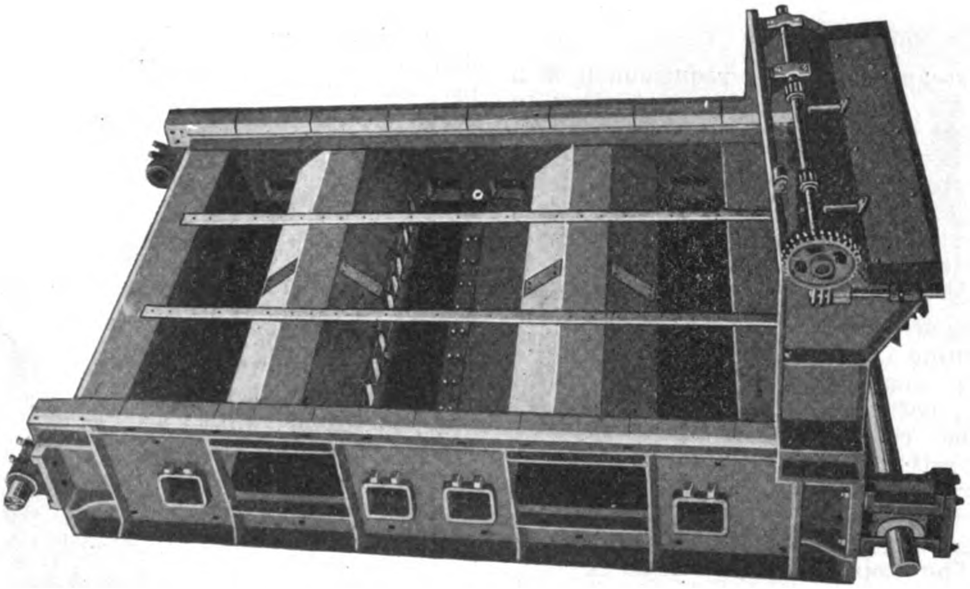




Type "E" Stokers.

Especially designed for economical combustion of bituminous and semi-bituminous coal, including refuse from bituminous mines.

The Type "E" stoker is the result of years of development and improvement on the earlier underfeed stokers. It has been for the past 12 years, and is now, in successful use throughout the world, burning coals of more widely varying character than any other stoker on the market, ranking from lignite or brown coal to semi-anthracite.



Elevation and Plain Perspective.

Coxe Stokers

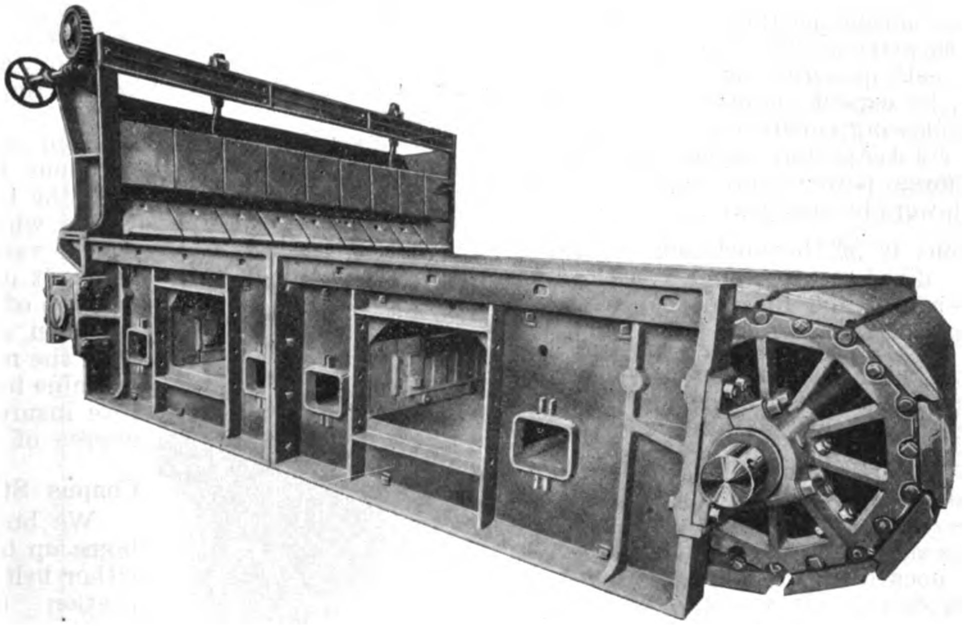
The burning of small sizes of anthracite coal and Coke Breeze has been a problem. The Coxe Stoker meets this problem and solves it.

The air is introduced to the stoker in separate compartments so that the pressure under the grate may be varied in accordance with the thickness of the fire above that compartment. This construction enables complete combustion of fine coal at the maximum rate, the air pressure in each compartment is under the direct control of the operator and may be varied at will.

The driving chains are located at either side of the stoker and are protected from the intense heat of the fire. The fuel is carried on narrow castings called keys which are in turn strung on carrier bars. Carrier bars are not subjected to the heat of the fire. This feature alone makes the maintenance of the fuel operating surface of the grate very low.

The keys are so designed that they are perfectly ventilated at all times which prevent their getting overheated and prolong their life indefinitely.

The power required to drive the stoker is negligible, being less than one H. P. on most stokers. The stoker is practically automatic.



Perspective Side and End View.

Coppus Engineering & Equipment Company

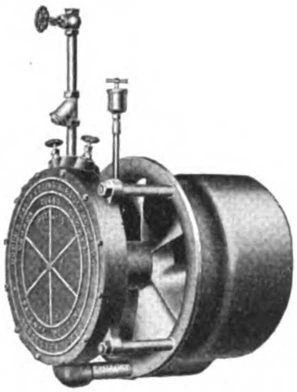
Main Office and Works
344 PARK AVE., WORCESTER, MASS
Manufacturers of

Turbo Blowers, Damper Regulators and Steam Turbines

Forced Draft for Boilers

To keep up steam is the first requirement in a mine boiler plant. Sometimes it is necessary to burn good salable coal when refuse coal is available and even then the steam pressure will drop. The Coppus Turbo Blower increases the capacity of boilers from 100% to 200%, keeping the steam pressure constant all the time and not making it necessary to install more boilers and allowing to keep one or more boilers out for repairs and cleaning.

For the burning of the so-called refuse coal, as anthracite dust, soft coal, slack and bone coal, a blower of some sort is necessary. Not every blower, however, will burn these fuels with the same degree of efficiency. The Coppus Blower has been especially designed to meet the specified operating conditions in each individual plant and is not simply adapted for all conditions. For this reason these are several Coppus designs.


Coppus Turbo Propeller Blower.

We build our blowers with either single or double stage turbine, with different types of exhausts, with outboard or inboard bearings, with straight or expanding fan casings, and equip each size with any one of one-half dozen different fans, whichever is best adapted to the conditions. Where necessary, special designs for unusual requirements are furnished. The Coppus is built to stand the "acid test" of actual use. The superior design is backed by expert manufacturing ability. These and the following construction features are the secret of our success and explain why half a million boiler horse power were equipped with Coppus Turbo Blowers in four years.

1.—The Coppus is of the enclosed, separately mounted, large diameter turbine type, which means quiet operation and high economy at the most efficient fan speeds.

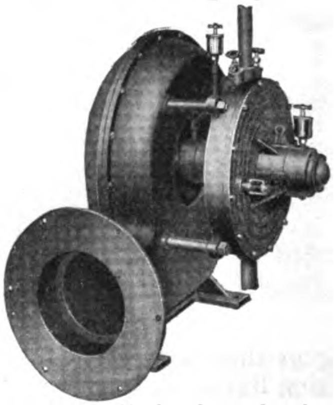
2.—The Coppus is the only turbo-blower of this type in which the fan does not overhang the bearing and in which the exhaust steam can be discharged into the fan casing, when so desired.

3.—The Coppus was the first turbo-blower with individual nozzle control, in which the steam chamber is sectionalized into small compartments for each nozzle and does not extend clear around the periphery of the casing. It was the first to use ball bearings, and in the Type B it was the first to use an outboard bearing for the turbine.

4.—The Coppus Turbo Blower—size for size—delivers more air at any specified pressure and uses from 25% to 75% less steam than any other turbo blower made. We will be glad to back up this statement by a comparative test. The Coppus has replaced a great many other blowers, but no other blower has ever replaced a Coppus.

Coppus Turbo Centrifugal Blowers

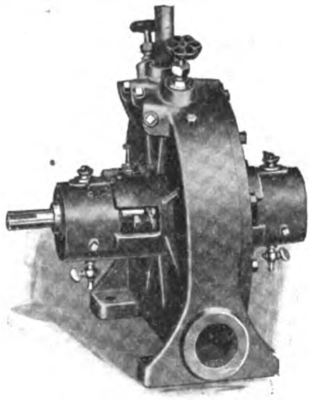
While the Coppus Turbo Blower for forced draft for boilers may be used for other purposes, as, for instance, ventilation, the Coppus Turbo Centrifugal Blower has been especially designed for conditions where higher pressures are required than is economical to give with the propeller type blowers. This blower being built in small and large units, and being portable, may be used to very good advantage for ventilating mine shafts, and may be driven by either steam or compressed air. The blower is also admirably adapted for stokers where a higher pressure is necessary than our standard blower for undergrate draft can give economically. It further finds a wide range of use in manufacturing plants for cooling rolls and other industrial purposes.


Coppus Turbo Centrifugal Blower.

Coppus Damper Regulator

The Coppus Damper Regulator is used to operate the Coppus Turbo Blower automatically through means of a balanced valve and is a guarantee for constant steam pressure, as it takes the regulation of the blower out of the hands of the fireman.

Damper Regulators have been used for a large number of years, and the Coppus Damper Regulator has been patterned after the type which has given the best satisfaction and which allows the widest range of adjustment. It enjoys the distinction of being built in our own shop, equipped with the most up-to-date machine tools, and therefore insures the highest degree of workmanship.


Coppus Steam Turbine.

Coppus Steam Turbines

We build steam turbines up to 50 H. P. for either belt or direct connection to propellers, dynamos, blowers, and pumps.

CYCLONE GRATE BAR COMPANY

BUFFALO, NEW YORK

Manufacturers of

Grates and Grate Bars

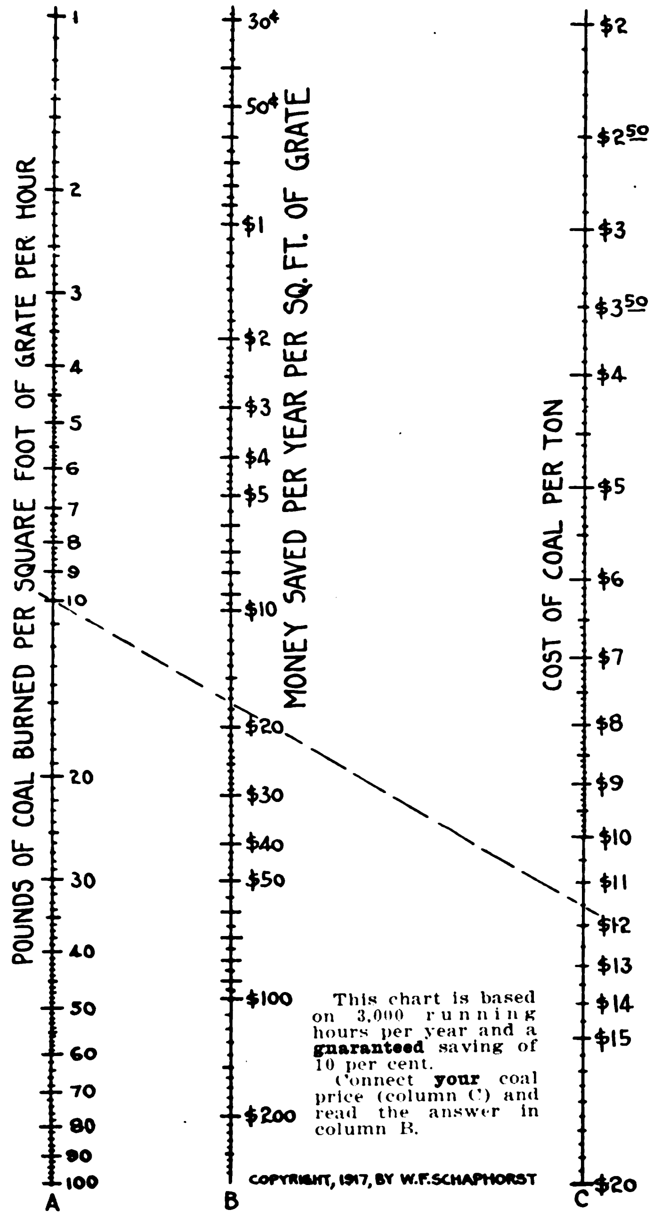
Products

Cyclone Grates and Cyclone Grate Bars.

Guaranteed Saving

We make this **guarantee** unhesitatingly to any mine owner or other responsible person who is now using plain grates under his boilers and who wants to improve his methods—"A Cyclone Grate will save **at least** 10 per cent. of your coal, other conditions being equal—boiler efficiency, fireman's efficiency, etc." We invariably do **much better** than 10 per cent., but there is a limit to the percentage we can **guarantee,** of course. A saving of 20 per cent. is not uncommon for Cyclone Grates.

You can save this much per sq. ft. if you are now using plain grates.



This chart is based on 3,000 running hours per year and a **guaranteed** saving of 10 per cent.

Connect **your** coal price (column C) and read the answer in column B.

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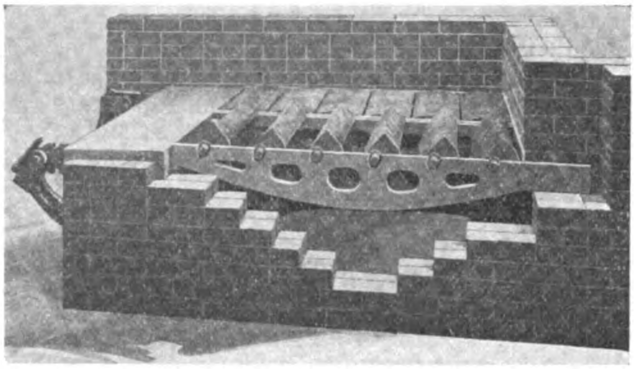


Money Talks

How much does your coal cost per ton, right now? Find the corresponding point in column C of this chart. How many pounds do you burn per square foot per hour? Find the corresponding point in column A. Connect the two points and the intersection with column B gives the yearly saving **per sq. ft. of grate.** Now multiply by your grate area. The answer is the money **you** can save per year by installing Cyclone Grates. Remember, it's a **guaranteed** saving—a guarantee that is backed up by a well known and solidly established firm that has already installed **hundreds** of grates all over the country.

For Example

The dotted line drawn across the chart solves an **actual** problem of today. You certainly don't have to pay $11.50 per ton, but if coal costs you, say, only $2 or $2.50 per ton you will find that Cyclone Grates **pay,** and **pay big.**

Usable In Mine Plants

Coal now costs more at the mines than ever before. It is doubtful if coal will ever be cheaper. You know that. It therefore behooves the miner as well as all other consumers to **save coal.** There is no better method than via the Cyclone Grate. Heat, first, should be saved **at the source.** The grate is the Source. After installing the right kind of grate you can begin thinking about making further savings—in the engine—feed water heaters—ecanamizers, etc.

Modern

The Cyclone Grate is **modern** in every particular, embodying novel features that every coal consumer should know about. It is simple and durable. Any fireman of reasonable intelligence can operate it correctly. It is so designed that chipping, breaking, burning-out, etc., are very very rare.

Construction

Of the Cyclone Grate is pretty well shown in the photograph above. We haven't space enough to describe all details here but we have literature fully covering every point which we will gladly send on request.

McCLAVE-BROOKS COMPANY

NEW YORK OFFICE
351 Fulton Bldg., 50 Church St.

MAIN OFFICE AND WORKS
SCRANTON, PA.

CHICAGO OFFICE
515 Hearst Bldg.

Manufacturers of

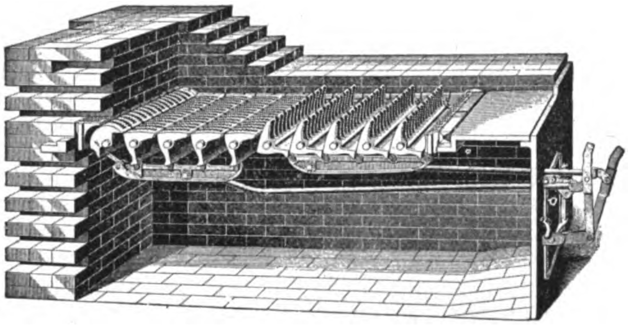
Stokers; Shaking, Cut-off and Dumping Grates, and Steam Blowers

Products

McClave Grates; Shaking, Cut-off and Dumping Movements; Sectional Removable Top Grate Bars; McClave Stokers; McClave Furnaces; McClave Argand Steam Blowers. All kinds of Iron and Brass Castings.

McClave Grates

McClave Grates, with Argand Steam Blower, are designed for burning the cheaper and finer grades of fuel.



Grates Nos. 1 and 2 are principally used for Soft Coal; Nos. 3 and 4 for smaller sizes of Hard Coal. Grate bars are furnished with suitable mesh for the fuel to be burned, 3-32 in. mesh being the smallest. All burn larger sizes by natural draft.

Details of Construction

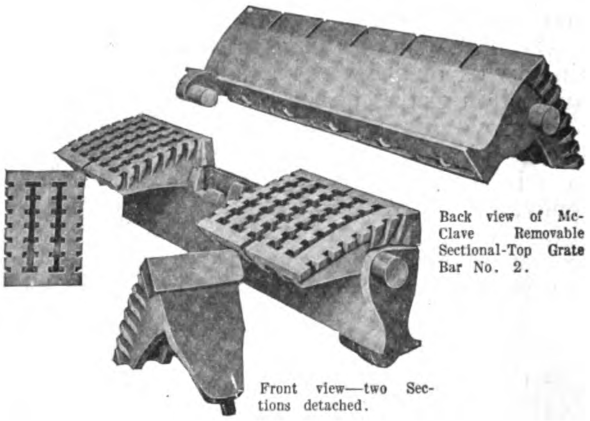
Grates No. 1 and 2 have an absolute cut-off movement in which each row can be operated as a whole, or the front and rear separately as desired; also a shaking movement in which there is no increase in the opening between the bars, consequently no waste of unconsumed fuel.

In the No. 1 grate the regular bars are cast integral: i. e., the top and pendant portions are cast in one piece. In No. 2 Grate the regular grate bars are made with sectional removable tops, similar to the No. 3 Grate.

Grate No. 3 has a double cut-off movement, in which each row can be operated as a whole, or the front and rear separately. The grate bars are made with sectional removable tops.

Grate No. 4A is a dumping grate fitted with twin levers for operating the front and rear series of bars separately. The grate bars are made with sectional removable tops which overlap each other, and have beveled edges which allow for the expansion of the top without interfering with the use of firing tools when cleaning fire.

All journal bearing bars have expansion tops made with locking caps and plugs over the journals which prevent the bars from jumping out of the journals when cleaning the fire. All forgings and fittings are drop forged.

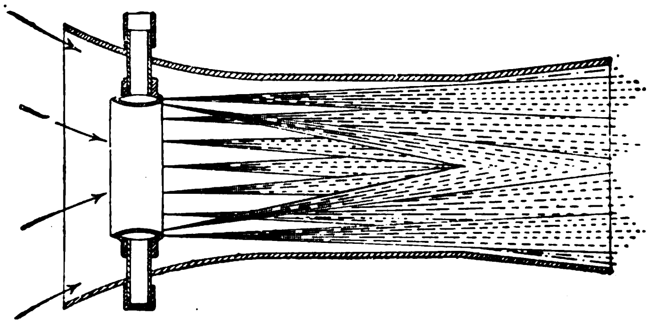


Back view of McClave Removable Sectional-Top Grate Bar No. 2.

Front view—two Sections detached.

McClave-Argand Steam Blower

Better combustion of lower grade fuels, such as anthracite buckwheat, birdseye, rice, and bituminous slack, screenings, duff, etc., is produced by a forced draft, and experts concede that a properly proportioned air and steam blast, such as that produced by the McClave-Argand Steam Blower, will produce better results than an all air blast for the following reasons:



With a coal that tends to clinker, the steam and air blast will keep the clinker comparatively soft and porus.

The steam moistens the fine ashes in the lower stratum of the fire, preventing their being blown up to choke the fire.

Each furnace has its own blower, hence is independent of a fan system or blowing engine.

Features of McClave Systems

McClave grates have no long lines of metal in contact with the heat, consequently cannot warp from the action of the heat of the fire on the grate. The sectional tops are interchangeable and easily replaced when required.

The movements of the grate provide methods for cleaning fires in the least possible time and without waste of unconsumed fuel. Grate bars are made with different sized meshes to suit the various grades and sizes of fuels, from 3-32 in. upwards. The constructions as a whole are very strong and durable.

POWER EFFICIENCY CORPORATION

BUFFALO, N. Y.

Manufacturers of

The "Long's Duplex Shaking Grates"

Products.

Long's Duplex Shaking Grates. Special Shaking and Dumping Grates Air cooled Carrier Bars.

Construction.

The Long's Duplex Shaking Grate is of extra heavy construction. Each installation weighs 15 to 20 pounds per square foot more than any other type of shaking or dumping grate. Only the best of materials and workmanship is used.

Air Cooled Carrier Bars.

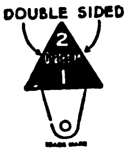
All side and center carrier bars have cored openings. This insures a constant circulation of air—the most effective guarantee against warping.

Triangular Shaking Bars Give Two Working Surfaces.

Each shaking bar is cast in the form of an equilateral triangle, the strongest construction possible. Beveled air slots greatly increase the circulation of air passing through the grates.

Description.

The Long's Duplex Shaking Grates are designed to burn any kind of coal. Dirty clinkery coal can be burned without clinkers forming if properly operated. We claim that these grates will cut down your fuel bills from 10 to 25 per cent. Further, the use of slice bars, pokers, etc., is eliminated.



Installation.

These grates can be installed in any fire box. As each set is made up for its particular job, no changes in brick work are necessary. Each set of grates is assembled complete and tested before it is shipped.

Guarantee.

All material and workmanship are guaranteed against defects for the period of one year from date of shipment.

Points of Superiority.

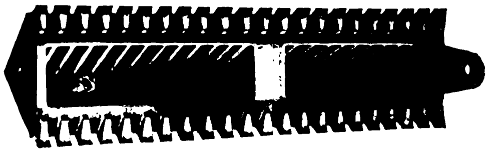
1. Each installation a separate engineering problem.

2. Heaviness of construction combined with two working surfaces insure longer life and fewer repairs.

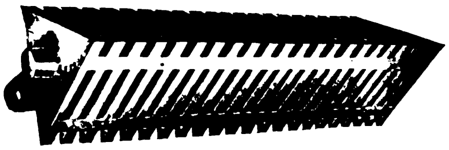
3. A great saver of fuel.

4. Fewer parts means a saving of time and cost of operation.

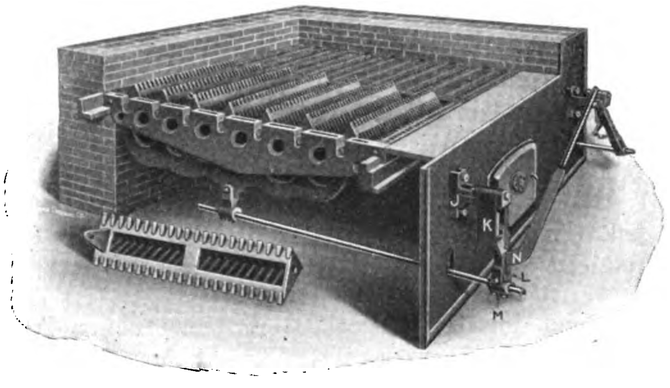
5. Higher boiler efficiency — more steam per pound of fuel burned.



Under View of Triangular Bar.



Top View of Triangular Bar.



The Long's Duplex Shaking Grate.

VALLEY IRON WORKS

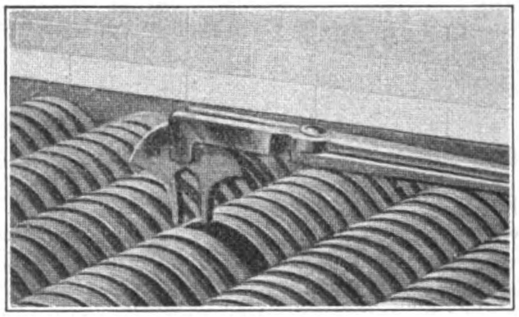
OFFICES AND WORKS
WILLIAMSPORT, PA.

Manufacturers of

Ajax Rocking and Dumping Grates

Products

Ajax Rocking, Shaking and Dumping Grates, Chemical Machinery, and Shafting Appurtenances.



Special Features

Stands of its own legs, not fastened to brick work.

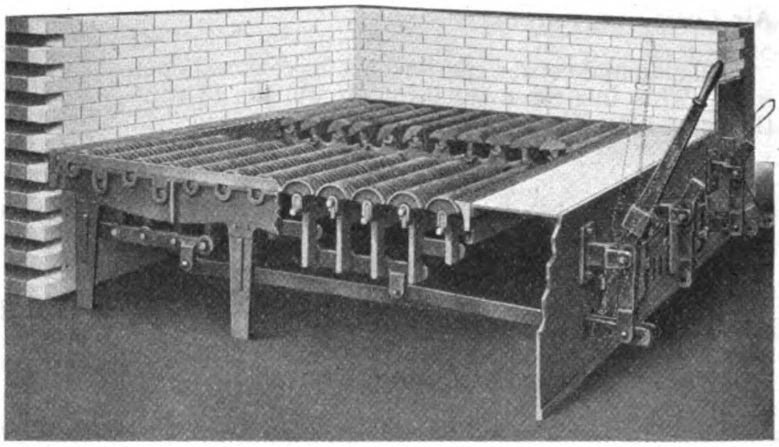
Air space over 60%, more air, more oxygen, more dioxide, more heat.

Greater steaming capacity. More heat, more steam.

Low cost of repairs. Top of grate practically all single saddles.

Are being used at more than 300 mines.

Initial cost no more than other types —upkeep cost considerably less.



What They Will Do

Will make steam with **Bone Coal** that has 30% ash and 40% or more fixed carbon.

Will make steam with **Breeze Coke.**

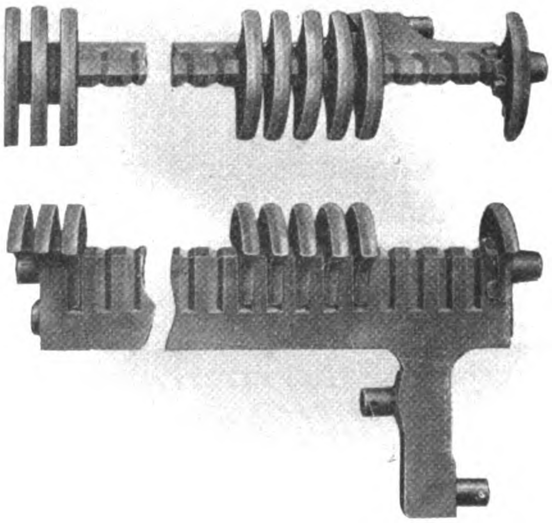
Guaranteed, as compared with plain grates, to save 10% fuel when using good coal, and usually save 15% to 20%.

Guaranteed, as compared with plain grates, to increase steam capacity 10%, usual increase from 15% to 30%.

Makes it easier for firemen. No slicing or poking. Cleaning through fire door very much reduced or altogether unnecessary.

Send for list of coal companies using Ajax Grate.

Ajax Grate Catalog sent on request.



Schaffer Engineering & Equipment Company

TIFFIN, OHIO

MANUFACTURERS OF

Schaffer Poidometers

The Poidometer

This machine will automatically weigh and record screenings coal, deliver to boilers or automatic stokers with a guaranteed accuracy of 99.5 per cent., and by so doing will save labor and give an accurate record of the fuel handled. It is also indispensable for correct weighing of coal into washing plants.

Operation

In service, it is desirable to connect the hopper of the poidometer to a bin which contains the material desired to be delivered and weighed. Where a bin is not practical, we build a sheet metal hopper and bolt it to the cast iron hopper, which give flexibility to allow the machine to operate satisfactorily, receiving its material direct from an elevator or conveyor. Its installation is easily accomplished, as it is built self-contained. It is only necessary for the poidometer to be supported at two points. These supporting points can be at each end of the channels or near the center.

When the material is delivered into the poidometer hopper, it is prevented from clogging or bridging by an agitator which makes a half revolution and reverses itself. This is the only correct principle of agitating and causing solid materials to flow freely. After the Poidometer is installed, the amount of material to be delivered is merely a matter of setting the weights on the scale beam to the designated amount and putting the machine in operation, whereupon it will deliver so many pounds per minute, hour or day, and no more or less, with an accuracy of 99.5 per cent.

It is foregone conclusion that the machine cannot fail to do this, inasmuch as the principle of weight against weight, is the only correct scale or measurement of gravity that will probably ever be known. It is interesting to watch the hopper gate perform its work of releasing and cutting off the flow of material. When the machine is receiving its material and is in operation, about all that can be noticed in the movement of the hopper gate is a flutter which can be aptly compared with the movement of the stem in a ball governor on a steam engine. This fluctuation is caused by the constant difference between weight and volume. The operation of the machine is fundamentally based on the travel of the belt at so many feet per minute and the delivery of a certain number of pounds per running foot of belt. The weight per foot of belt is determined by setting the weight on the scale beam. The travel of the belt is constant, therefore, it reduces itself to a simple proposition. Bear in mind that its operation is entirely automatic.

Sizes and Capacities

No. 20 Machine—10 lbs. per min. to 2,500 lbs. per min. on pulverized and granular materials up to 1¼ in. cubes. (In case material is coarse as 1½ in. cubes, it must contain 30 per cent. fine material to insure the guaranteed accuracy.)

No. 28 Machine—30 lbs. per min. to 6,000 lbs. per min. on pulverized and granular materials up to 3 inch cubes. (In case material is as coarse as 3 inch cubes, it must contain 30 per cent. fine material to insure the guaranteed accuracy.)

No. 36 Machine—50 lbs. per min. to 21,000 lbs. per min. on pulverized granular materials up to 4 inch cubes. (In case material is as coarse as 4 inch cubes, it must contain 40 per cent. fine material to insure the guaranteed accuracy.)

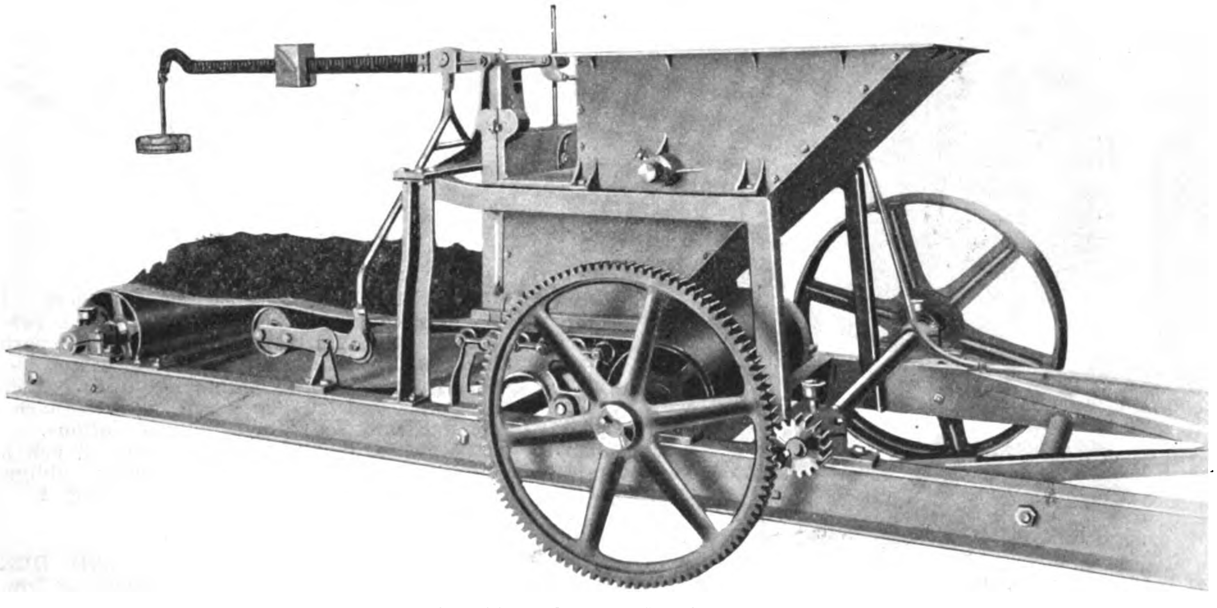
The above capacities are based on materials weighing approximately 100 lbs. to the cubic foot. Any lighter material will cut the capacity and heavier material will increase the capacity in proportion.

In gauging the machines before shipping, we should know within 33 1/3 per cent. your maximum and minimum desired, as we can adjust the machine to suit conditions in the factory and the scale beam will give you a flexibility of 33 1/3 per cent. either way in operation. The machine is capable of great adjustments in the field with very little trouble by reason of screw take-ups in the walking beam, and other features.

Installation at a Coal Mine

A No. 36 machine weighing 70 tons of coal per hour to automatic stokers. This machine automatically stops when it does not receive coal by reason of delays in hoisting from the mine, and is started by an operator in the coal tipple 500 feet distant, when the coal begins to come again. It weighs and records the amount of coal that is passing over it each day. The action of the machine is indicated at all times by a system of light signals in the coal tipple, and starting switch is controlled at the same point, making the machine's operation entirely automatic as far as it possible in receiving its material direct from a mine.

Other installations are numerous and equally interesting. Further information will be given upon request.



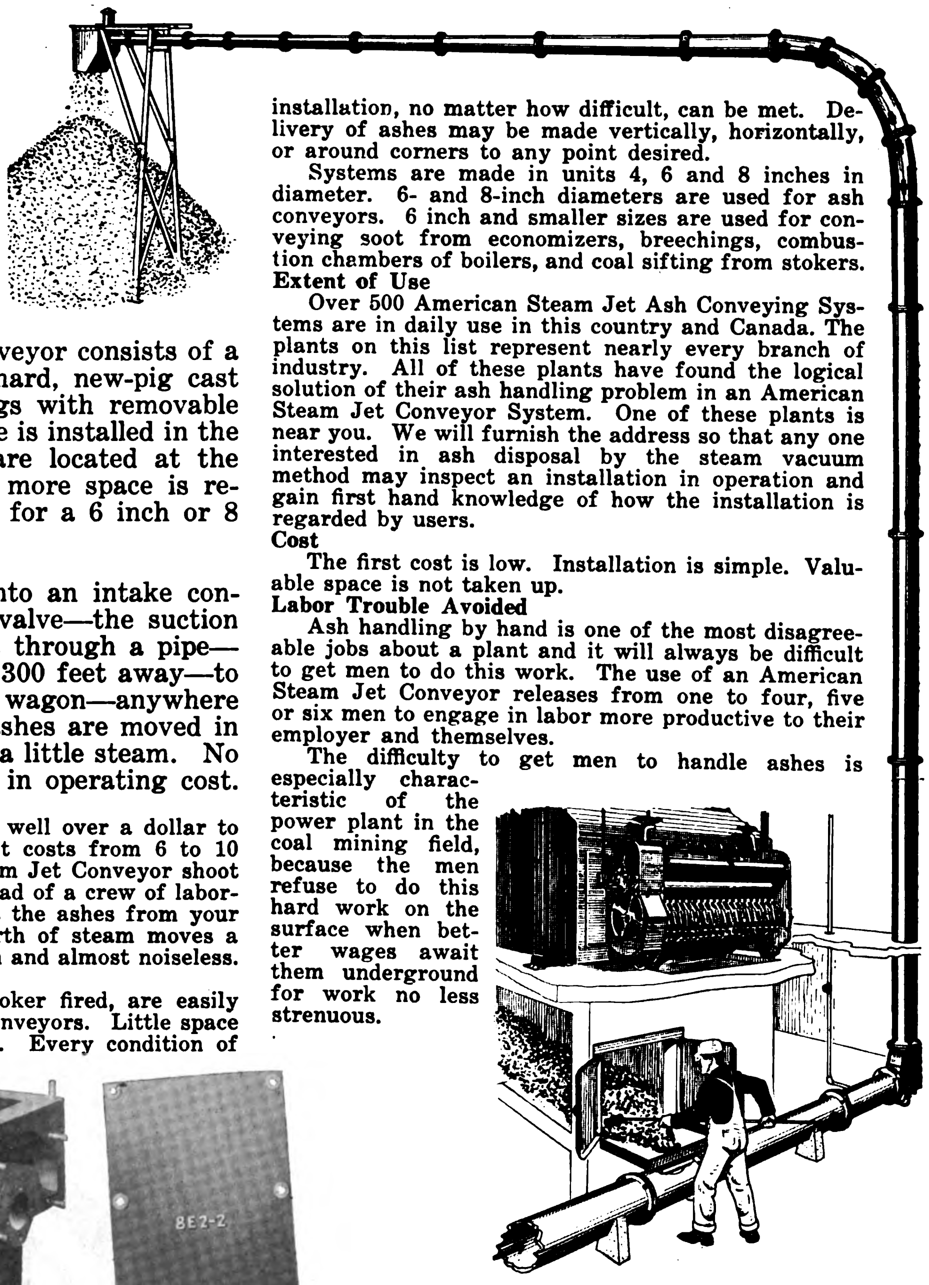
No. 36 Poidometer Handling Coal.

American Steam Conveyor Corporation

Consolidating the Systems, Patents and Personnel of Girtanner-Daviess Engineering Co. and the Griffin Engineering and Construction Co.

CHICAGO: 326 West Madison Street NEW YORK: 50 East 42nd. Street

Engineering and Sales Offices in All Other Principal Cities.



The Product

AMERICAN STEAM JET CONVEYORS for economical handling of ashes, combustion ashes, soot, blast furnace dust, coal siftings, etc., from boiler or furnace room to any point desired. The largest line of fittings made by any company manufacturing non-mechanical ash disposal systems.

Construction

An American Steam Jet Conveyor consists of a heavy pipe line made of very hard, new-pig cast iron and special patented fittings with removable hard metal wear parts. Pipe line is installed in the boiler house and ash intakes are located at the most convenient points. Little more space is required for the installation than for a 6 inch or 8 inch pipe line.

Operation

One man rakes the ashes into an intake conveniently located. He turns a valve—the suction of a steam jet shoots the ashes through a pipe—100 feet up if required—100 to 300 feet away—to pit, pile, overhead hopper, car, wagon—anywhere desired. Three to ten tons of ashes are moved in an hour and the expense is just a little steam. No system so simple—none so low in operating cost.

Saving

It costs from 20 cents to a figure well over a dollar to handle one ton of ashes by hand. It costs from 6 to 10 cents a ton to have an American Steam Jet Conveyor shoot them anywhere you want them. Instead of a crew of laborers doing the work, one man removes the ashes from your boiler room. From 3 to 5 cents' worth of steam moves a ton of ashes and the operation is clean and almost noiseless.

Easy Installation

Old and new plants, hand and stoker fired, are easily equipped with American Steam Jet Conveyors. Little space is required and installation is simple. Every condition of installation, no matter how difficult, can be met. Delivery of ashes may be made vertically, horizontally, or around corners to any point desired.

Systems are made in units 4, 6 and 8 inches in diameter. 6- and 8-inch diameters are used for ash conveyors. 6 inch and smaller sizes are used for conveying soot from economizers, breechings, combustion chambers of boilers, and coal sifting from stokers.

Extent of Use

Over 500 American Steam Jet Ash Conveying Systems are in daily use in this country and Canada. The plants on this list represent nearly every branch of industry. All of these plants have found the logical solution of their ash handling problem in an American Steam Jet Conveyor System. One of these plants is near you. We will furnish the address so that any one interested in ash disposal by the steam vacuum method may inspect an installation in operation and gain first hand knowledge of how the installation is regarded by users.

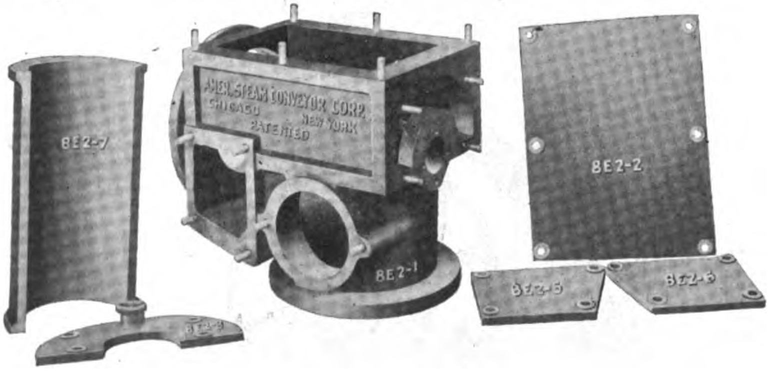
Cost

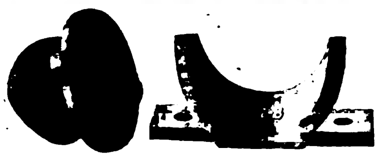
The first cost is low. Installation is simple. Valuable space is not taken up.

Labor Trouble Avoided

Ash handling by hand is one of the most disagreeable jobs about a plant and it will always be difficult to get men to do this work. The use of an American Steam Jet Conveyor releases from one to four, five or six men to engage in labor more productive to their employer and themselves.

The difficulty to get men to handle ashes is especially characteristic of the power plant in the coal mining field, because the men refuse to do this hard work on the surface when better wages await them underground for work no less strenuous.





American Patent Steam Unit.
One of the large line of fittings which make this system so flexible that any conditions encountered in installations may be met with the minimum cost for engineering, construction and erection.

Manufactured and Installed By Engineers

The great success of American Steam Jet Conveyors is the direct result of scientific experiment and exhaustive tests by our engineers.

Experts in ash handling give each contract personal attention. They are in close touch with 500 successful American Steam Jet Conveyor installations. They are familiar with every conceivable phase of economical ash handling. Advice and suggestions are free, and without obligation. Write for more information. Be sure to ask for Catalog E.

A New Book

"MODERN METHODS OF ASH HANDLING AND DISPOSAL," containing information of value and interest to owners, superintendents and engineers has been published in a limited edition. A free copy will be sent on request.

GEORGE J. HAGAN COMPANY

4th Floor, Peoples Bank Bldg.,
PITTSBURGH, PA.

4th Floor, Garfield Bldg.,
CLEVELAND, O.

Engineering Offices in All Principal Centers

NEW YORK CITY, Frank W. Richardson, 39 Cortland St.
CHICAGO, Reordway Company, Marquette Bldg.
BOSTON, Henry J. Sage, 79 Milk St.
PHILADELPHIA, Eugene Hahn, 709 Harrison Bldg.
ST. LOUIS, O. L. Collins & Son, Bank of Commerce Bldg.

Hagan Products

Hagan Combustion Regulator; Hagan Gas Producers; Hagan Stoker Fired Metallurgical Furnaces, for all purposes.

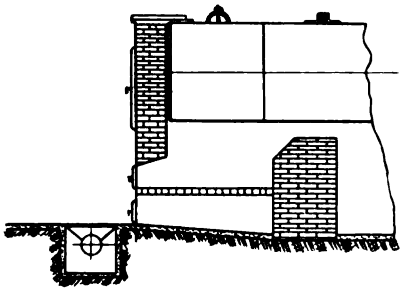
Representatives for the Combustion Engineering Corporation of New York, handling the Type E Stoker, Type H Stoker, and the Coxe Stoker for burning coke breeze.

Description

The operation of a steam jet ash conveyor is simplicity itself. Imagine a straight eight inch pipe line in front of your boilers, both ends of the line open. Steam flowing through a nozzle located at the proper place causes air to pass through the pipe in large quantities, at high velocities.

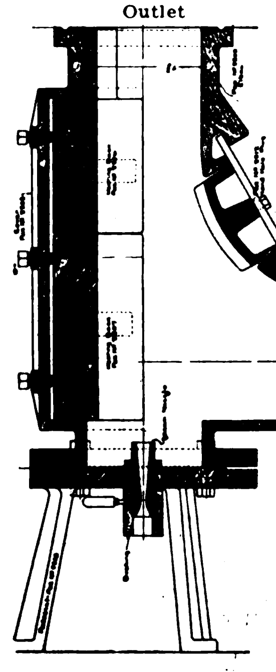
Several openings are left in the pipe at different points thru which ashes are raked into the air current.

The ash laden air current can be directed to suit conditions and ash delivered to a tank, wagon, railroad car or dump pile at any point to suit your convenience. A brick dropped in the ash intake will appear on your dump pile **a few seconds** later.



Hagan System Applied to H. R. T. Boiler.

Could Anything Be More Simple?



Hagan Signal Elbow showing Wearing Backs and Nozzle.

All steam jet ash conveyors are operated in this manner, and until the Hagan was placed upon the market they were all as much alike as wheelbarrows.

Construction

We want, however, to particularly call your attention to the **Distinctive Features of the Hagan Conveyor.**

The Signal Elbow. This undoubtedly represents the greatest improvement that has ever been made to this class of equipment. One of the big objections raised in the past to the steam jet ash conveyor was **the large quantity of steam required.** This objection is absolutely eliminated with the **Hagan Signal Elbow.**

The **Patented Steam Nozzle** device used in connection with this fitting **Cannot take more Steam than the conveyor is designed for, Unless you want it to.** This one feature alone may be worth hundreds of dollars per year to you.

Another objection that has been raised to this class of equipment was the fact that the special hard iron wearing backs if not properly inspected from time to time would wear thru and result in damage to the expensive fittings they were intended to protect. **All Hagan Fittings are protected against damage of this kind.**

The method used for connecting the pipe and fittings together is a **Hagan Feature** and is employed by this conveyor **only.**

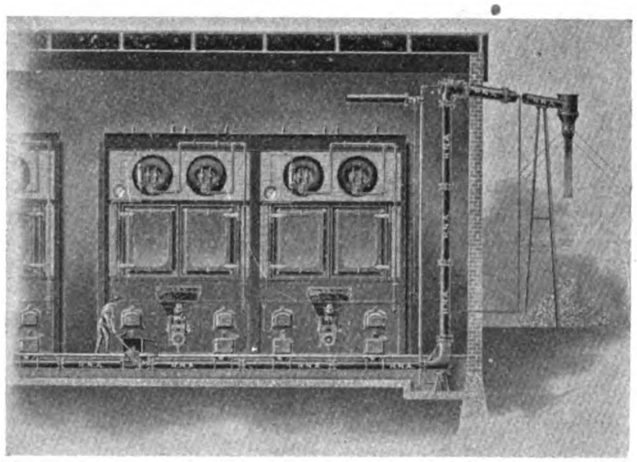
It has **six distinct** advantages that will be gone into in detail with you upon request.

The Ash Intakes are **self cleaning.** The **target box** has been designed with the same amount of care and thought that characterizes the rest of the conveyor.

The **steam turbine** of today is the result of the constant demand for greater efficiency. The **Hagan Ash Conveyor** is the result of this same demand.

Adaptability

Wherever a steam jet ash conveyor system is advisable, the **Hagan** can be used. There are some conditions under which it is **NOT advisable** to select a steam jet conveyor. Our Engineers will tell you if yours is one of them.



The operation is "Simplicity" itself.

Advantages of the Hagan Steam Jet Ash Conveyor

Positive assurance of efficient operation and minimum up-keep.

Ease of operation; ease of installation and repair.

No costly changes needed in your plant to accommodate it.

Promotes cleanliness in your boiler house.

Cuts down your labor costs and removes your labor troubles.

Makes your firemen's work a pleasure.

KNOW THE HAGAN BEFORE YOU BUY.

ALLIS-CHALMERS MFG. CO.

MILWAUKEE, WISCONSIN

Branch Offices in All Principal Cities

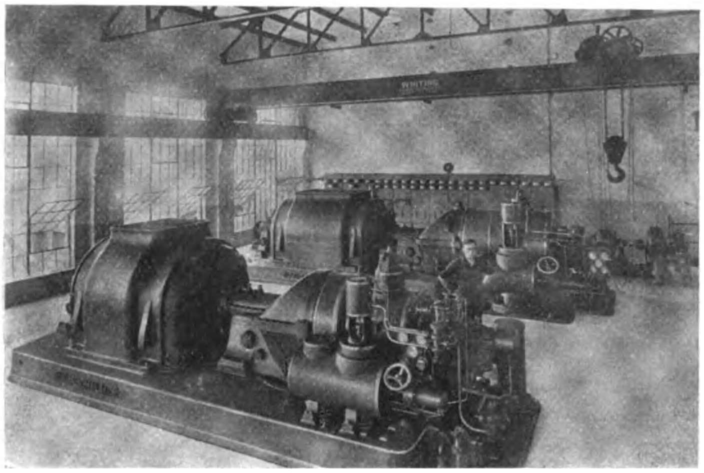
Power and Electrical Equipment for Mines

Products

Turbines, Condensers, Corliss Engines, Boiler Feed Pumps, Alternating and Direct Current Generators and Motors, Rotary Converters, Transformers, Switchboards, Motor-Generator Sets, Air Compressors, Electric and Steam Driven Hoists, Centrifugal Pumps, Coal Crushing Rolls, Crushers and Pulverizers, Revolving and Shaking Screens, Power Transmission Machinery.

Steam Turbine

The Allis-Chalmers turbine is made in all commercial sizes. The demand is primarily for high pressure condensing machines; however, the Company builds all types, including low and mixed pressures. The generators are wound for both direct and alternating current. The steam turbine (because of its simplicity, low cost of up-keep and great economy, together with its compactness), is a very desirable prime mover for coal mining purposes.



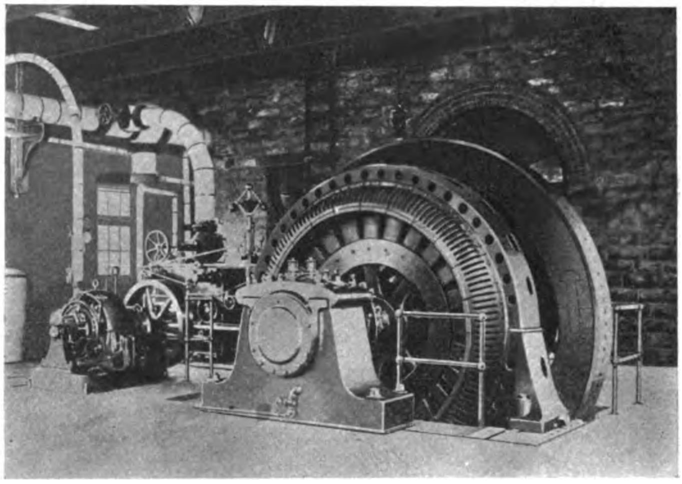
Steam Turbine.

The small turbines are designed with great simplicity for direct-connection to pumps, blowers, small generators, etc. Send for Bulletin No. 1084.

Corliss Engines

This type of prime mover is used where conditions of operation make it better suited to coal mining conditions. This Company manufactures both steam engines and turbines, and gladly extends the service of their Engineering Department to assist in the design as to the proper type of prime mover to install in order to meet any specific condition.

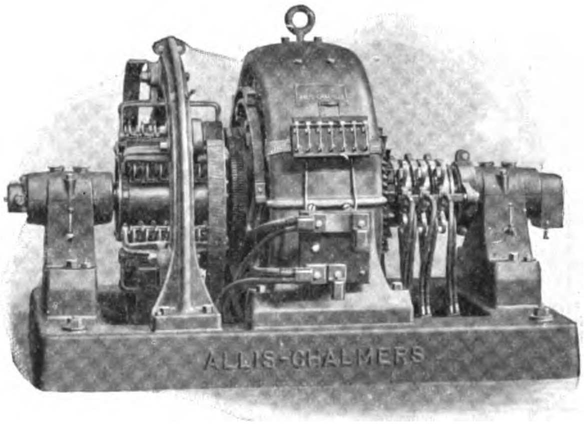
The heavy duty one-piece frame and slide (all machined at one setting), the patented adjustable ball and socket type self-aligning bearings, the enclosed type governor, are a few of the many distinctive features in the design of this engine. The machines are built for direct-connection to generator, ventilating fans, etc., or for belting, as the conditions require. Send for Bulletin No. 1529.



Corliss Engine Generator Unit. McKell Coal & Coke Co., Kilsyth, W. Va.

Rotary Converters

The Rotary Converters designed for mining service are very rugged in construction and capable of carrying large overloads. They are built in standard capacities of 100-kw and larger.

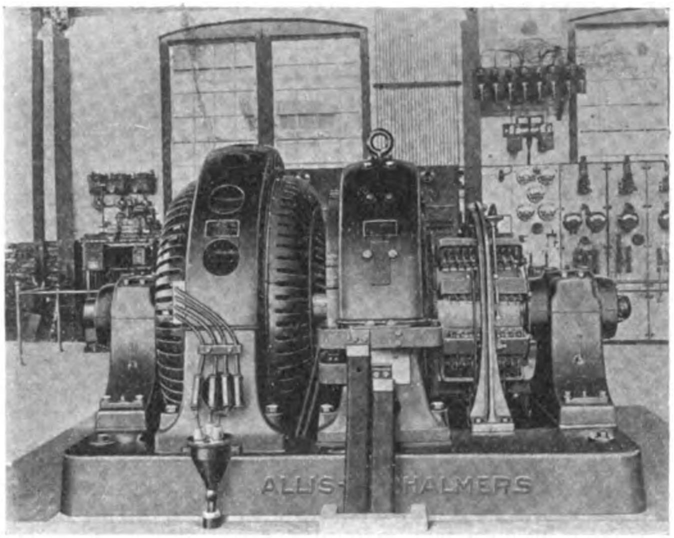


200 K. W. Rotary Converter for Mining Service.

The machines have commutating poles, special moisture-proof form wound coils and are self-starting from either side. The bearings are of the pedestal ball and socket type, and are self-oiling and self-aligning. The liberal and open design affords means for inspection and cleaning. Send for Bulletin No. 1092-A.

Motor Generator Sets

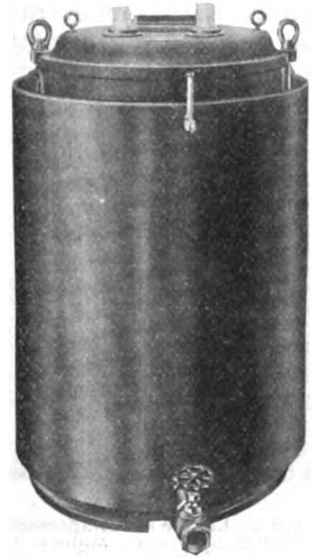
The Motor-Generator Sets are built in all standard sizes for coal mine service. The special moisture-proof form wound coils, the correct and liberal design of all parts, assures large momentary overload capacity. The pedestal ball and socket type of self-oiling bearings, the method of supporting the brush rigging, etc., affords ready access for inspection and cleaning. Combinations are built of self-starting synchronous motors, induction motors, direct current, two and three-wire generators, etc. Send for Bulletin No. 1090-A.



Synchronous Motor Generator Set.

Transformers

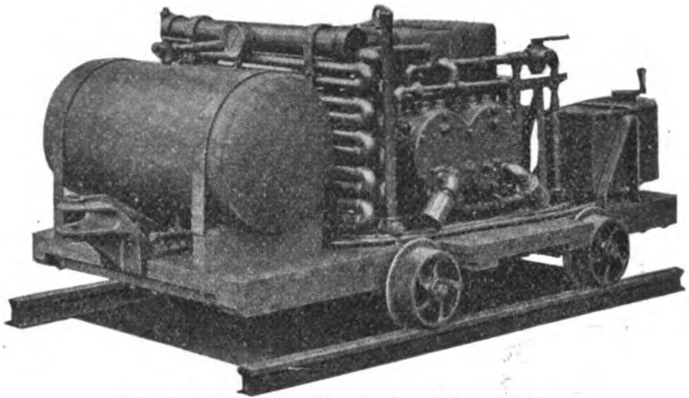
These transformers are designed for power and lighting service. They are built in all commercial sizes for lighting and power transmission and for use in connection with Rotary Converters. They are furnished in self-cooled, water-cooled and air-cooled types, wound for all voltages and frequencies embodied in coal mining service. A distinctive feature of the Allis-Chalmers self-cooled transformers is the jacketed tank, giving three or more cooling surfaces. Send for Bulletins Nos. 1097 and 1088.



Oil Filled Self-Cooled Power Transformer.

Air Compressors

This type of air compressor is particularly adapted for coal mining service. It is built in sizes ranging from 11 cu. ft. to 50 cu. ft. capacity and either motor driven or belted type. They are used for supplying compressed air at 100 to 125 lbs. pressure for drilling overcasts and holes for line material, riveting mine cars, spraying paint, operating jack hammer drills, cleaning machinery, etc. These machines can be mounted on standard mine car trucks, and if desired may be self-propelled for use in the mine. Send for Bulletin No. 1536.

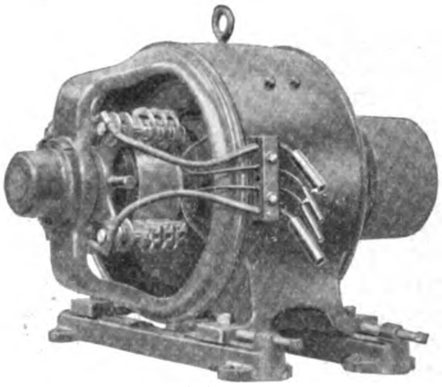


Portable Air Compressor for Mine Service.

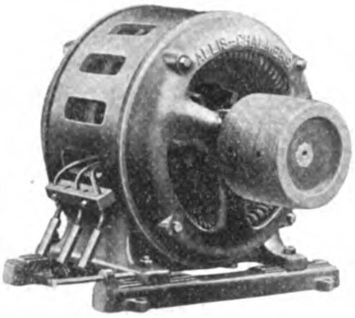
Motors

The Allis-Chalmers Manufacturing Company also manufacture large capacity motor or steam engine driven air compressors of the stationary, single and two-stage type for Power Plant installation. Send for Bulletin No. 1531.

This Company manufactures a complete line of both direct and alternating current motors. The machines are designed with large overload capacity and for all commercial ratings and including a wide range of speeds. The direct current motors are of the shunt, series and compound, open or enclosed type. The alternating current motors are squirrel cage (including two speed for fan drive), wound rotor and synchronous type. All are furnished for standard voltages used in coal mine service. The heavy frame construction, self-oiling bearings and large shafts are a few of the notable features in their design. Send for Bulletins Nos. 1087-A and 1096.



Type "K" D. C. Motor.



Type "AN" Induction Motor.

GENERAL ELECTRIC COMPANY

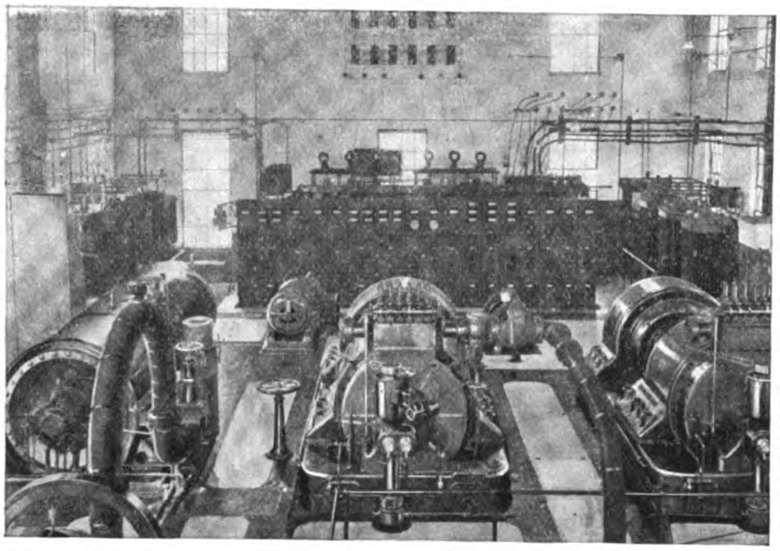
General Offices:
Schenectady, N. Y

The Guarantee on Goods of Excellence Electrical

Sales Offices
In All Large Cities

ELECTRICAL EQUIPMENT FOR MINES

The engineers of the General Electric Company have been designing and supplying special electrical apparatus for mine use during the last quarter century. The data and experience from many thousand mine installations, all over the world, is available to our designers of special electrical apparatus for mine use including steam turbines, generators, transformers, switchboards, motors and control equipment, motor generator sets, rotary converters, electric mining locomotives of every type and combination of types desired, portable mine air compressors, etc., etc.



Curtis Steam Turbine Power Plant, Davis Coal and Coke Co., Thomas, W. Va.

The Curtis turbine is made in all sizes from a few kilowatt capacity, up to the largest in existence. It is not only more economical than other types, but its high economy is maintained over wide variations in load.

Aside from the resulting saving in coal, less load is imposed on the boiler plant, and in many cases an appreciable saving in cost of coal handling and firing has been effected. That this feature is generally understood and appreciated by mining companies is shown by the very large number of Curtis Turbines employed in this class of service.

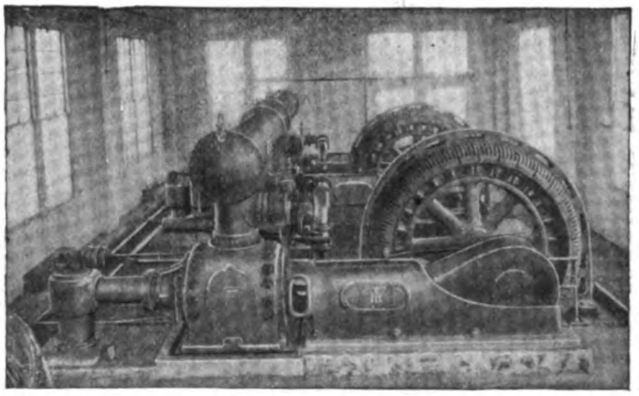
The Curtis Turbine is designed throughout with an extremely liberal factor of safety; constructed of the very best material, correctly proportioned for the service required. The stresses to be met are determined with absolute exactness. The selection of material to be used is governed not only by the results of long experience, but by constant and rigorous tests. The complete Curtis Turbine is, therefore, as nearly perfect mechanically as it is possible to build. As a result, power supplied by Curtis Turbines is seldom interrupted by shut downs, and operators are assured of constant operation of motors, hoists and other electrically driven apparatus.

Geared turbines are available in a considerable range of sizes, adaptable to direct current generators, or other apparatus which runs at lower speed than the most efficient turbine speed. The gear is simple in construction, and its initial high efficiency is maintained in service.

A number of small turbines are available, particularly designed for direct mechanical drive, that is, for connection to pumps, blowers, etc., for which class of work the small and compact design and few parts render them particularly suitable.

The electric end of Curtis Turbine sets consists of a generator embodying the superior features characteristic of all G-E generators, combined with a mechanical design particularly adapted to the turbine which drives it.

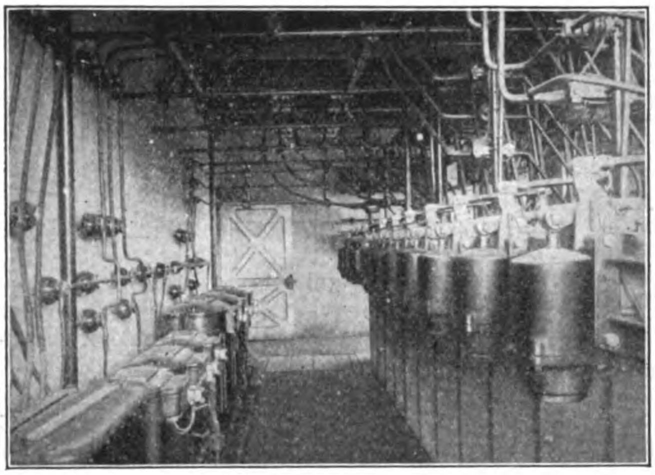
The extreme operating temperatures of the generators, are all well within the limits which insulation will satisfactorily withstand. This assures ample margin for unusual or extraordinary conditions, as well as long life for insulation.



2650 Cu. Ft. (At 100 Lb.) Air Compressors, Driven by 450 kv-a., 6000 Volt Synchronous Motors, Rochester and Pittsburg Coal and Iron Co., Punxsutawney, Pa.

Synchronous motors are furnished for driving air compressors and improving the power factor of mine transmission lines having a large induction motor load.

The General Electric Company transformers furnished for mine use are stanchly made and capable of withstanding rough treatment in transportation as well as severe service operating conditions.

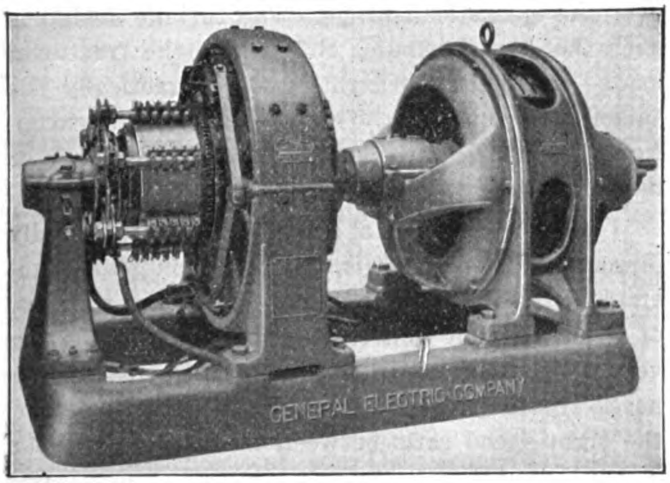


G-E Transformers and Oil Switches; Buffalo, Rochester and Pittsburg Coal and Iron Co., Punxsutawney, Pa.

They are designed and built to meet all the exacting requirements attendant upon mine conditions. In their construction are embodied the same features which have given to G-E transformers the preference with the great central stations in this country.

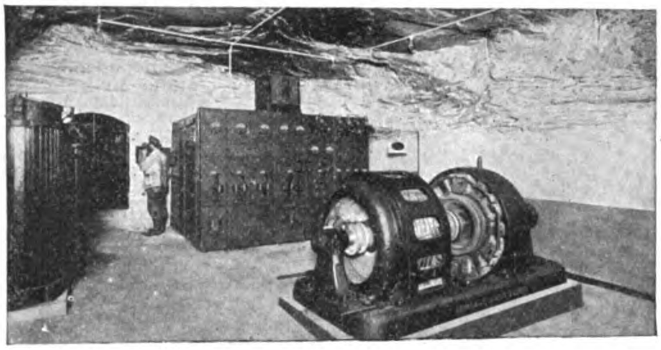
Motor generator sets manufactured by the General Electric Company are designed to assure continuous operation under the varying conditions of load found at mines. These sets will stand from 100 to 150% overloads momentarily without injury.

Fire proof series and commutating field windings of a self ventilating type, armature equalizer connections mounted on back of armature where they are easily kept clean and armature conductors held in place by wedges and easily replaced in event of accident are a few of many superior features found in these machines.



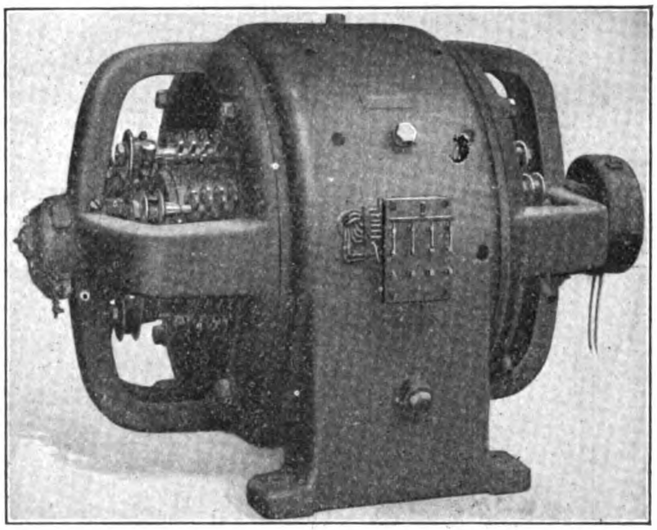
150 kw. G-E Motor Generator Set.

G-E switchboards for mine work are reliably and correctly designed, with special reference to mine conditions. Among their many advantages—where grounded neutrals are used in connection with mining locomotive service—these switchboards permit multiple connection of the series field of an incoming generator with those of running machines. This permits voltage adjustment before closing the main switch, insuring correct polarity of the incoming machine and the least disturbance in paralleling.



Underground Sub-station, Republic Iron and Steel Co., Sayreton Mines, Alabama.

G-E Rotary Converters designed for mine service are highly efficient and capable of carrying 100 to 150% momentary overloads. These machines are self-starting from the alternating current end, have moisture resisting windings and easily removable form wound coils and are successfully applied in many representative mines throughout the world in all sizes up to 4000 Kw. or larger.



100 kw. Synchronous Converter.

WESTINGHOUSE ELECTRIC & M'F'G CO.

EAST PITTSBURGH, PA.

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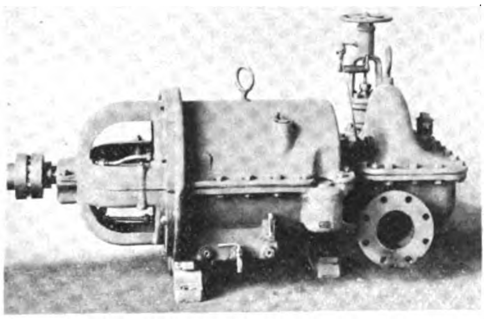
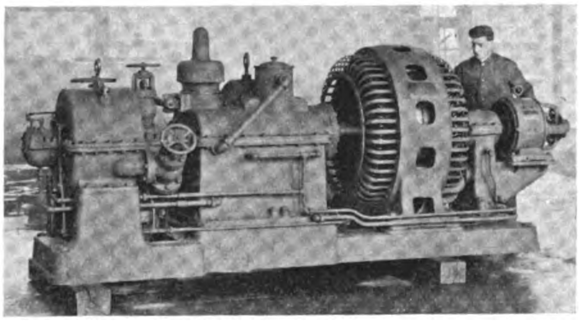
San Francisco, Cal.
Tacoma, Wash.
Toledo, Ohio.
Seattle, Wash.
Spokane, Wash.
Syracuse, N. Y.
Washington, D. C.

•W. E. & M. Co., of Texas.

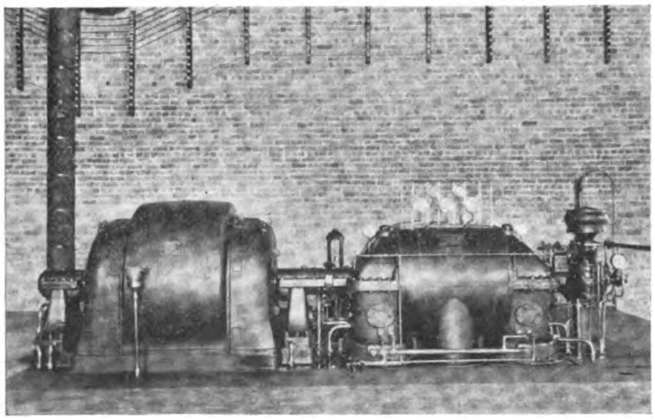
Mine-Power Equipment



50 H.P. Geared Turbine.



300 K.W. Alternating Current Turbo-Generator.



600 K.W. Low Pressure Turbine Units.

Turbo Generators

Westinghouse Steam Turbines range in capacity from 1 kw. up to 100,000 h.p.

The 50 h.p. Geared Turbine at the left is employed to drive pumps, fans, blowers, etc., as well as electric generators. These geared units range in capacity from 15 to 500 h.p.

The 300 kw. non-condensing Geared Turbo-Generator also shown represents our standard construction for capacities up to 1,000 kw.

The object of the Geared Turbine is to permit both the turbine and the unit it drives to operate at the speeds for which they are designed to give highest efficiency. The construction of both the turbine and the gear is very simple and rugged. The reliability of these units has been amply demonstrated by satisfactory service under severe operating conditions.

Another important advantage peculiar to the Westinghouse geared turbine is sustained economy over the entire load range. The turbine design is such that the economies obtained at the fractional loads—say, one-fourth rating—are practically the same as at full load. This is a feature of exceptional worth to the plant subject to seasonal or daily load fluctuation.

Condensing units above 500 kw. are usually direct connected—that is, the reduction gear is not employed. The gear is employed only in the case of direct-current generator drive, and in driving very large pumps—in both of which cases it is necessary to get, by means of the reduction gear, the right speed ratio between the turbine and the driven apparatus.

The advantages of steam-turbine units over reciprocating-engine driven outfits, are small floor space, simplicity of construction, lower maintenance cost, high efficiency and little attention required while in operation.

WESTINGHOUSE ELECTRIC & M'F'G' CO.

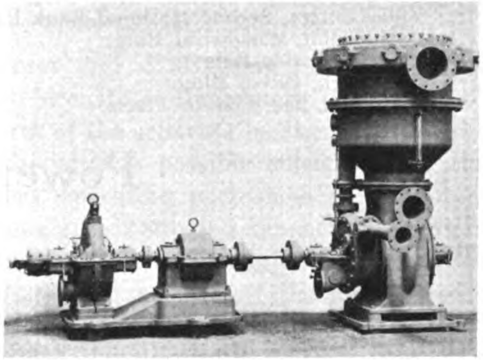
East Pittsburgh, Pa.

Condensers

Of the Jet, Ejector and Surface types.

Westinghouse LeBlanc Condensers have become generally known and recognized as high-vacua condensers, because of their exceptional performance and their ability to maintain high vacua continuously with minimum attention and upkeep.

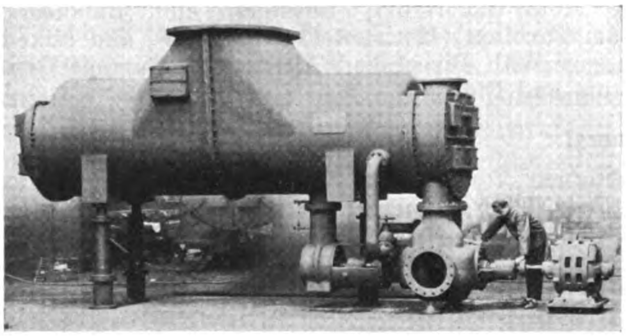
Their construction is simple and rugged in all respects. The pumps are all of the centrifugal type, operating at the most efficient speeds and adapted to either motor or turbine drive, as local conditions may require.



Westinghouse Jet Condenser.

Reliability is an additional factor which has brought about their extensive use in all parts of the world, in the most remote localities.

Westinghouse condensers are all equipped with the LaBlanc Pump, which is the most effective apparatus known for the production of high vacua. Unlike the reciprocating pump, the LeBlanc pump becomes more efficient as an air remover as the vacuum increases. Being of the centrifugal type, all troubles incident to valves and reciprocating parts of the steam engine, are eliminated.



Westinghouse Surface Condenser.

Stokers

There are Three Distinct Types of Westinghouse Stokers:

(1) Underfeed
(2) Overfeed (Roney)
(3) Chain Grate

Although the latter two are lower in first cost, the great sererve capacity, high efficiency over a large load range, and the ability to burn all coals efficiently, always compensate for the higher first cost of the Underfeed and result in its selection where local conditions will permit its application.

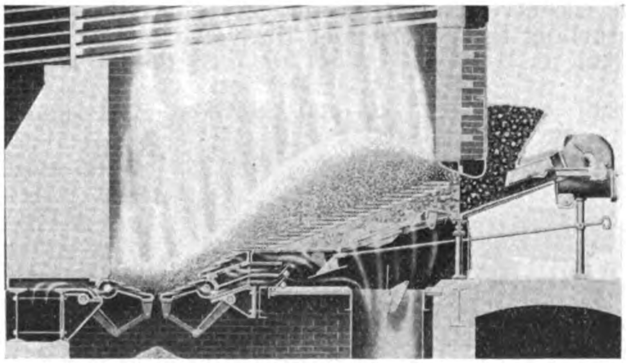
The Westinghouse Underfeed is built for boilers of all sizes and types, and the industrial plant is as largely benefited as the big central station where heavy overloads occur periodically and suddenly.

The Underfeed has an overload capacity of from 300 to 400%, and the point of highest efficiency remains between rating and 150% of rating, which is the load common to industrial plants.

The Roney Overfeed Stoker is desirable for plants with more even load conditions and the absence of auxiliaries and the simplicity of the ash pit construction make it easy to install, and at lower first cost.

The Chain Grate Stoker is desirable where there is sufficient space in front of the boilers to permit its withdrawal from the furnace for repairs and where underground ash pits and conveying system can be installed.

However, the choice of a stoker always narrows down to a study of plant requirements. Our recommendations are always based on facts ascertained by a thoruugh investigation of fuel, load and other local conditions.



Sectional View of the Westinghouse Underfeed Stoker.

RIDGWAY DYNAMO & ENGINE CO.

MAIN OFFICE AND WORKS
RIDGWAY, PENNSYLVANIA

Branch Offices and Agencies:—

Boston, 53 State St.
New York, 38 West 32nd St.
Philadelphia, Real Estate Trust Bldg.
Wilkes-Barre, Second National Bank Bldg.
Washington, Woodward Bldg.
Atlanta, Healey Bldg.
Pittsburgh, Oliver Bldg.
Cincinnati, 250 Senator Place.

Cleveland, Schofield Bldg.
Chicago, Marquette Bldg.
St. Louis, Chemical Bldg.
Denver, Lindrooth, Shubart & Co., Boston Bldg.
Minneapolis, L. E. Pollard, 505 Metropolitan Bank Bldg.
Seattle, Hallidie Machinery Co.
New Orleans, Electrical Appliance Co.

BUILDERS OF

Power Plant Equipment

Products

Steam Engines (Horizontal), Single-Valve Type, Side and Center Crank; Four-Valve Type, Side Crank; All Engines Built Simple, Tandem or Cross Compound. Generators, Direct and Alternating Current Types, Belted, Direct Connected, and Coupled. Motor-Generators, Boosters, and Balancers. Steam Turbines (Horizontal) High, Low, and Mixed Pressure with Direct and Alternating Current Generators and Blowers.

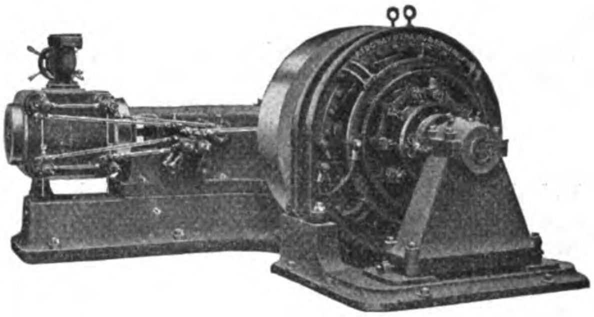
General

Ridgway Power Plant Equipment is recognized as a standard for Mining Work. This is due to several reasons, among which are 20 years' experience in building such equipment, a complete line of standard Engine-Generator Units especially designed for that work, and an organization of engineers and salesmen which is constantly looking out for the best interests of the user, even after the equipment has been accepted and paid for. Since the complete unit is the product of a single factory, there is no divided responsibility with its attendant troubles.

Engines

Ridgway Side Crank Engines, Single and Four-Valve Types, are fully enclosed and splash oiling. The main bearings are two part boxes with wedge adjustment. The connecting rods have solid ends with phosphor bronze boxes, babbitt lined on the crank end. The cross head bodies are made of cast steel with phosphor bronze shoes. The governor is of the centrifugal-inertia type and represents the highest development of the shaft governor.

The main governor bearing is of the roller type. The eccentric and strap may be removed without disturbing the governor or the valve setting.



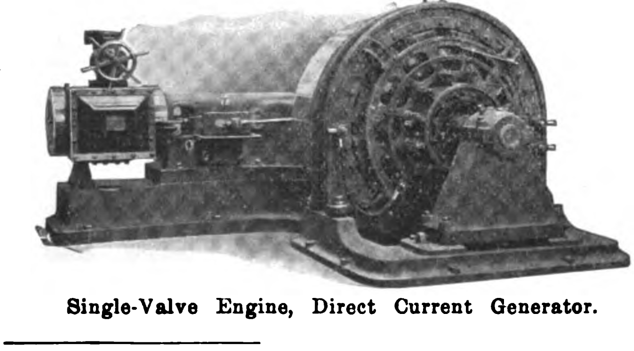
Four-Valve Engine, Direct Current Generator.

Single-Valve Engines have a flat balanced valve with double admission and exhaust edges.

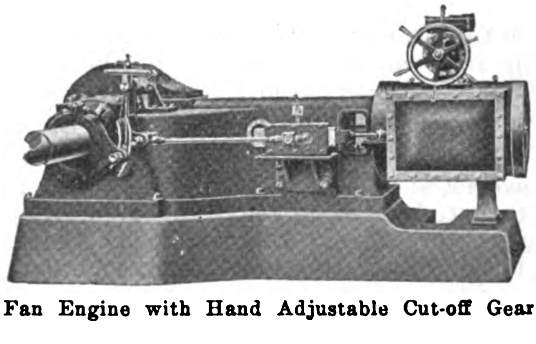
In case water is carried into the cylinder, both valve and pressure plate will lift from the seat and allow the water to pass directly into the exhaust.

Four-Valve Engines have semi-rotary, semi-balanced, double-ported valves. The valve gear is extremely simple and the principal moving parts run in oil. The motion of the valves is the same as on Corliss engines with the resulting high economy, augmented by careful design and workmanship. This engine has a distinct place in mining operations, where reliability and simplicity are desirable.

Engines of all types are built for belted, direct connected and coupled service. A special line has been developed for driving mine fans, pumps and similar service. These engines are fitted with an adjustable cut-off gear controlled by hand, fly-ball governor, or pressure cylinder. With any of these engines the speed may be adjusted at any time, and with the fly-ball governor the Engine will maintain its speed under varying load or steam pressure.



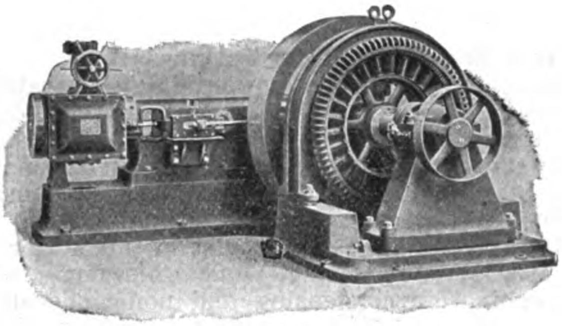
Single-Valve Engine, Direct Current Generator.



Fan Engine with Hand Adjustable Cut-off Gear.

Direct Current Generators

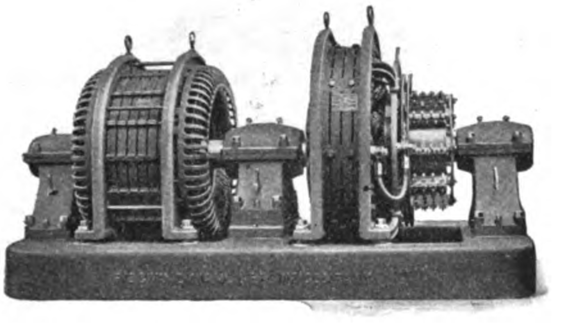
Ridgway Direct Current Generators are provided with a compensating field winding, making them capable of handling the most extreme overloads without sparking. For mining work where load fluctuations are severe and sudden they are without an equal. The field is of laminated construction throughout and responds almost instantly to changes in the magnetizing current. This feature means better regulation than is possible with a cast iron or cast steel field. Three-wire generators are built from the two-wire designs with but slight changes in the connections.



Single-Valve Engine, Alternating Current Generator.

Alternating Current Generators

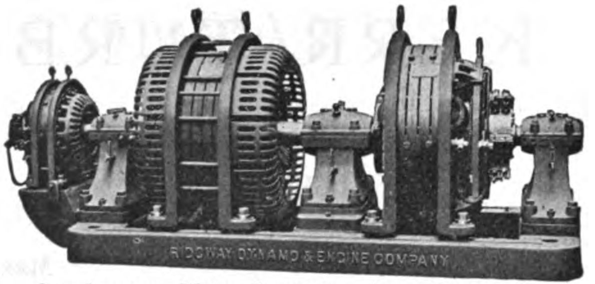
Ridgway Alternating Current Generators are built according to the latest ideas for such machinery. All sizes are built with revolving fields, having strip wound field coils on the large machines and wire wound coils on the small. The armature core is clamped between heavy cast iron rings in such a way as to leave the core exposed, thereby securing the maximum ventilating effect. Alternators are wound single, two and three phase, for 25 or 60 cycles, and for the usual standard voltages. The line covers direct connected, belted, and coupled or water wheel type machines.



Induction Motor-Generator Set.

Motor-Generators

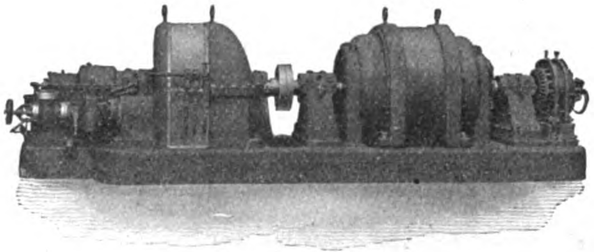
The increasing use of central station power in mining and other operations has created a demand for motor-generator sets of various characteristics, and especially for transforming alternating to direct current.



Synchronous Motor-Generator Set with Exciter.

Ridgway Direct and Alternating Current Generators combined into Motor-Generators possess all of the good features of the separate machines, and make a set having the highest possible efficiency and the most satisfactory operating performance. Combinations can be made of self-starting synchronous motors with or without separate exciters, induction motors, direct current two and three-wire generators, series boosters and direct current motors. Sets with synchronous motors can be arranged to operate with either end acting as the motor.

Ridgway motor-generator sets are in use in every coal field of the United States, especially in sizes from 100 K. W. to 300 K. W. inclusive. When the incoming line voltage is variable and good direct current regulation is necessary or desirable, a Ridgway motor-generator set is the right equipment to install.



Turbo-Generator Sets

Ridgway-Rateau-Smoot Turbines with Ridgway Direct and Alternating Current Generators embody the latest improvements in the design of such machinery.

Particularly successful in mining plants, and where an increased power output, with no increase in boiler equipment, is desired. High, low and mixed pressure types. 250 K. W. to 3000 K. W.

Sizes

Simple Engines, Single Valve:—15 H. P. to 1000 H. P.
Simple Engines, Four-Valve:—75 H. P. to 1000 H. P.
Cross Compound Engines, Single or Four-Valve:—125 H. P. to 1500 H. P.
Tandem Compound Engines, Single or Four-Valve:—100 H. P. to 750 H. P.
Direct Current Generators, Engine Type:—10 K. W. to 750 K. W.
Direct Current Generators, Belted Type:—3 K. W. to 750 K. W.
Motor-Generator Sets, All Combinations:—5 K. W. to 1000 K. W.

KERR TURBINE COMPANY

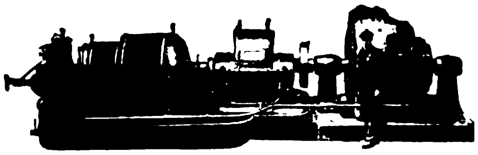
Works and Home Office
WELLSVILLE, N. Y.

Offices In All
Large Cities.

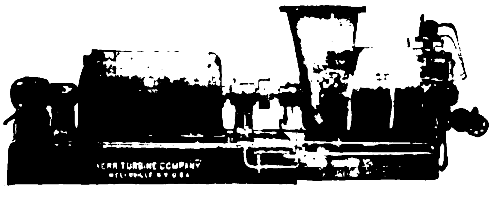
Manufacturers of

"Kerr Economy" Steam Turbine

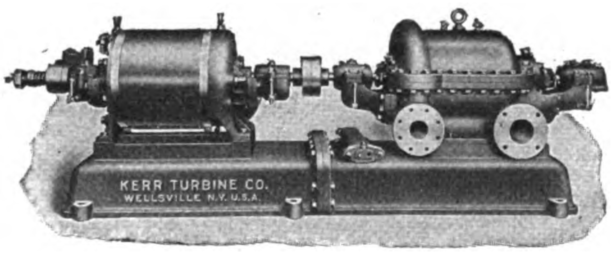
Connected Direct or Through Highly Accurate and Quiet "Kerr Economy" Herringbone Reduction Gears to Generators, Pumps, Blowers, Shafting, Etc.



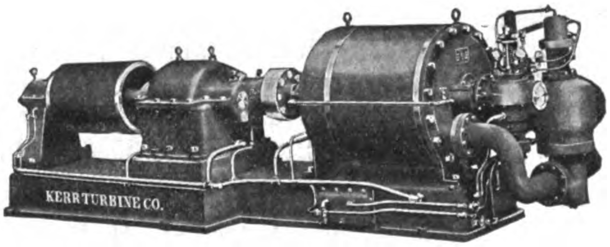
Standard 750 K. W. "Kerr Economy" Geared Direct Current Turbo Generator with Oil Relay and Emergency Governors.



500 K. W. Mixed Pressure "Kerr Economy" Turbo Alternator, built for Rockhill Coal & Iron Co., Robertsdale, Pa.

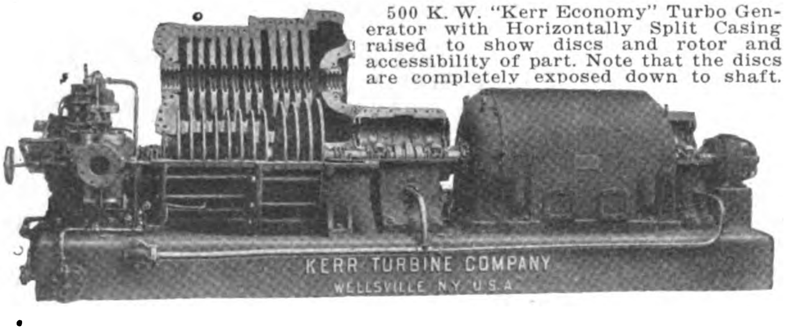


"Kerr Economy" Turbo Boiler Feed Pump.



"Kerr Economy" Geared Turbine for Belt Drive.

500 K. W. "Kerr Economy" Turbo Generator with Horizontally Split Casing raised to show discs and rotor and accessibility of part. Note that the discs are completely exposed down to shaft.



"Kerr Economy" Steam Turbines combine low first cost and minimum operating expense; require little floor space; are very economic in steam consumption; have practically no vibration, and require little or no attention or repairs.

Built for high pressure service—condensing or non-condensing—up to and including 1500 H. P. (1000 K. W.); also for exhaust steam (low or mixed pressure)—condensing,—and bleeder turbines (combination condensing and non-condensing for extracting part of the steam for heating system or for other purposes, when required, after having done work in non-condensing stages of the turbine.)

"Kerr Economy" Turbo-Generators, Pumps and Blowers have proven their superiority in coal and metal mining, power and pumping plants, steel plants, etc., and nearly every other industry.

"Kerr Economy" Herringbone Reduction Gears have proven themselves to be the best, the most quiet, the most accurate and the most efficient built in the United States. They have made possible the use of the "Kerr Economy" Steam Turbine operating at high and most efficient speeds, for driving low speed machinery and for belt or rope drive, as well as in connection with other prime movers driving machinery at other speeds than their own.

"Kerr Economy" Herringbone Reduction Gear.

The demand for "Kerr Economy" products has become so great that it is necessary to build an extension to our factory, which will more than double our manufacturing capacity.

BALL ENGINE COMPANY

ERIE. PENNA.

Builders of

High-Grade Steam Engines

Pittsburgh Representatives:

DRAVO-DOYLE COMPANY

Pittsburgh, Cleveland, Indianapolis, Philadelphia.

Products

Single Cylinder, tandem compound, and cross compound Single Valve automatic engines from 50 to 700 H. P. and non-releasing gear Corliss engines of the high speed type, single cylinder and cross compound from 125 to 1,200 H. P.

General

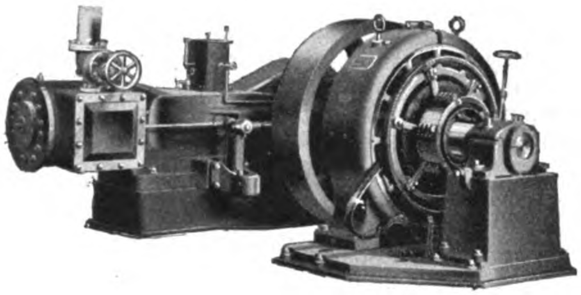
The Ball Engine has been recognized for many years as a standard for any work requiring an efficient and reliable power unit. Excellent design and construction have helped to build up a record of service unexcelled by any other similar machine. Hundreds of these engines are in daily operation in the coal industry, where the importance of reliability is keenly felt, and where the Ball Quality of service is heartily appreciated.

Construction

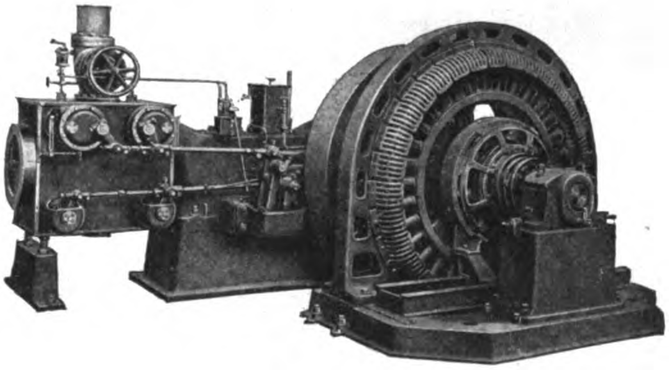
The Side Crank construction has been adopted because of its superior adaptation to conditions met in service. This construction eliminates the necessity for three bearings in engines direct connected to generators, and avoids the undesirable feature of an overhanging wheel which is particularly objectionable in the case of belt drives and in alternating current work.

The various details are substantial in design and material, and simple adjustments are provided wherever necessary.

The oiling system furnishes a reliable means of supplying oil to the bearings in any quantity desired. Adjustable sight feeds are provided for each bearing, and these are fed from a filter tank mounted on the top of the frame. A valveless pump of a special type which cannot be choked by waste or foreign substances, automatically pumps the used oil from the crank pit into the filter tank.



The Single Valve type of engine is extremely simple in construction, and, of course, lower in first cost than the Corliss type. It is largely used where simplicity of operation and low first cost are more important than low steam economy.



The Ball non-releasing gear Corliss Engine was introduced more than ten years ago, and is firmly established as an engine of exceptional economy and reliability. Its smooth operation, close regulation, and its characteristic faculty of "sticking to the job" have built up a considerable demand for this type in the coal field, as well as in many other industries where the service requirements are exacting.

INGERSOLL-RAND COMPANY

11 BROADWAY NEW YORK

Manufacturers of Compressed Air Coal Mining Machinery

Ingersoll-Rand Steam Condensing Plants

Beyer Barometric Condensers---Ingersoll-Rogler & Imperial Vacuum Pumps Cameron Water Pumps

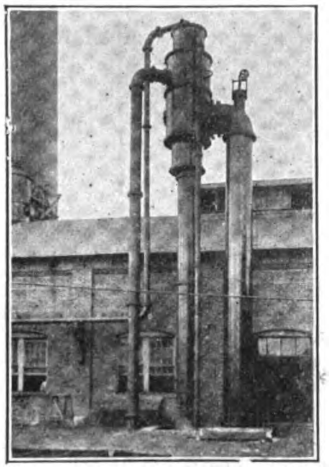
The Beyer Barometric Condenser is of the counter-current type and posseses features of design which render its action highly efficient and operating costs low.

Its distinctive advantages may be friefly stated as follows:

Maintenance of a consistantly high vacuum.

Great stability under sudden load changes.

High efficiency with varying load.



Consolidation Coal Co., Fairmont, W. Va.

Absolute protection against flooding of prime mover.

Uninterrupted service due to the ability to operate with dirty, acid or gritty water without necessitating shut-downs for cleaning or repair.

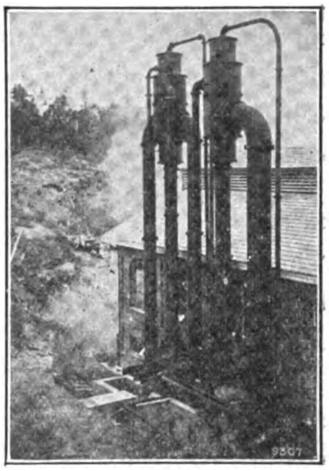
Low upkeep cost and freedom from need of renewing or cleaning tubes.

Extreme flexibility due to independent regulation of auxiliaries to suit varying conditions.

Ingersoll-Rogler (straight-line) and Imperial (duplex) Vacuum Pumps are equipped with noiseless air valves of highest efficiency. They are high speed machines with large capacity for a given size; they occupy less floor space.

Automatic flood lubrication and the dust and dirt proof construction make the attendance item a small one.

Piston valve steam engine and short belt electric motor drives attain highest economy in power consumption.



Alabama Fuel & Iron Co., Coalgate Station, Ala.

Cameron Centrifugal and Piston Water Pumps are reliable and of high efficiency. They can be depended upon to supply cooling water at least cost.

Numerous service reports of condensing plants operating under various conditions indicate unqualified satisfaction.

Ingersoll-Rand Condensing Plants are described in detail in Bulletin 9024.

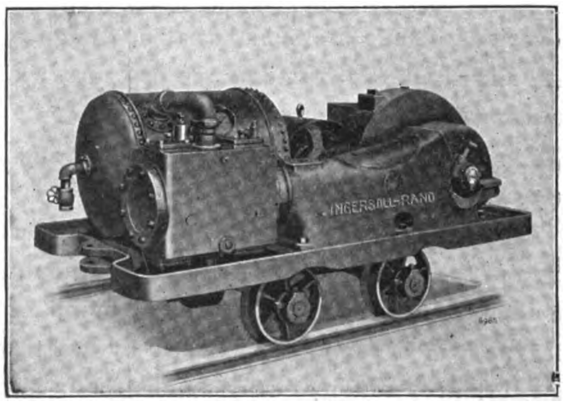
INGERSOLL-ROGLER MINE CAR COMPRESSORS

In every coal mine there are certain operations which can be done most rapidly and successfully by compressed air drills and cutters.

For the electrically operated mine, a mine car mounted, motor driven, portable compressor supplies compressed air where it is to be used without the expense of a permanent compressor station and extended pipe lines.

The "Ingersoll-Rogler" mine car compressor is especially designed for this service. It is of fully enclosed, dirt-proof construction, is automatically controlled, and is fitted with simple, durable and highly efficient "Ingersoll-Rogler" inlet and discharge valves.

Bulletin 3015.



"Ingersoll-Rogler" Class "ER" Mine Car Compressor.

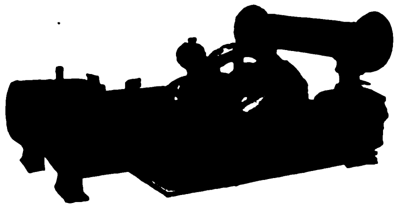
INGERSOLL-RAND COMPANY

11 BROADWAY NEW YORK

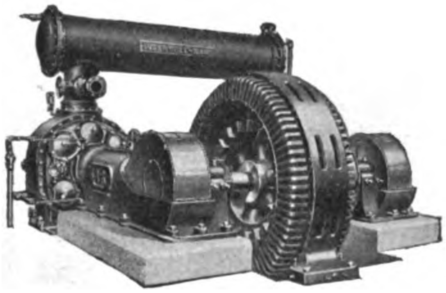
Manufacturers of Compressed Air Coal Mining Machinery

Air Compressors

To operate economically, the coal mine must at once provide for the economical production of power, as well as its utilization. Waste in power consumption and a loss of output, incident upon breakdowns, are costly items and will offset everything that may be gained through the use of otherwise highly efficient machinery.



"Imperial" Duplex Compressors—Capacities from 176 to 3620 cu. ft. per minute.
Type "XPV"—Steam Driven. Bulletin 3033.
Type "XB"—Power Driven. Bulletin 3312.



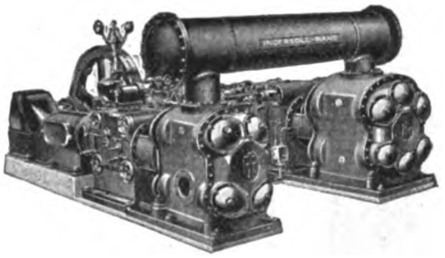
"Ingersoll-Rogler" Class "PRE"—Duplex, Direct Connected, Electrically Driven Type. Capacities 1000-10000 cu. ft. per minute.
Bulletin 3026.

Ingersoll-Rand compressors have proved, beyond a doubt, that they are economical in the production of power, low in maintenance cost, highly efficient and thoroughly dependable in service.

For ordinary service there are standard 100 pound machines, built in more than 150 sizes, from 3 to 10,000 cubic feet capacity. Reciprocating machines, both straight line and duplex, may be had power, short belt electric, direct connected electric, piston valve or Corliss valve steam engine driven. Turbo types may be had live or mixed pressure steam turbine driven.

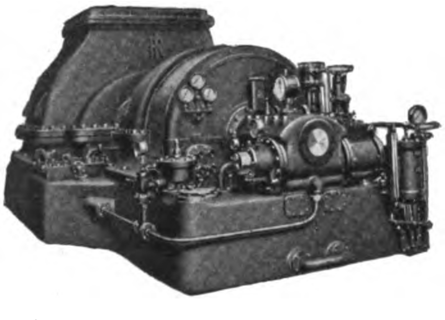
For high pressure work, such as compressed air haulage systems, compressors of two, three and four stages, delivering air at pressures up to 2500 pounds, are available.

You Can Depend On Ingersoll-Rand Compressors



"Ingersoll-Rogler" Class "ORC"—Duplex, Corliss Steam Engine Driven Type. Capacities 2500-10000 cu. ft. per minute.
Bulletin 3029.

Turbo Blowers for blast furnaces, cupola work, Bessemer converters, etc., may be had steam turbine or motor driven in capacities up to 60,000 cubic feet.



Ingersoll-Rand Turbo Compressors and Blowers, Cupola Blowers and Gas Exhausters.
Full information upon request.

Ask for the Bulletins.

MOLONEY ELECTRIC COMPANY

ST. LOUIS, MO.

FACTORIES:
ST. LOUIS, MO. WINDSOR, ONT.

DISTRICT OFFICES:
NEW YORK CHICAGO SAN FRANCISCO TORONTO, ONT. MONTREAL, P. Q. WINNIPEG, MAN.

Transformers For All Electrical Purposes

Our transformers have been on the market for the past twenty years and have met with universal success. During that period we have furnished transformers to all parts of the United States and all Foreign countries. Canadian trade is taken care of by our factory at Windsor, Ont.

Type H. E. 1 to 15 K. W. 2200 to 13200 Volts.

Type H. E. 20 to 100 K. W. 2200 to 13200 Volts.

Type F. 22000 to 33000 Volts. 10 to 100 K. W.

We furnish transformers in any voltage or size from 110 volts primary to 66,000 volts for both lighting and power service and for high transmission work.

The core loss and copper loss of Moloney Transformers is very low and the efficiencies very high.

Type C. 125 to 1000 K. W. 2200 to 33000 Volts.

The regulation is very close which is brought about through the use of special square and rectangular copper used throughout the construction.

The regulation is low and uniform; the windings are well ventilated in both the primary and secondary of our transformers permitting of a free circulation of oil through the entire transformer which results in a low and uniform temperature.

All mechanical details have been developed almost to a point of perfection. They are ruggedly built for excessive loads in connection with motor service.

Type T. 3 Phase, 2200 to 13200 Volts to 100 K. W.

A few illustrations on this page will only give a fair idea of our complete line which consists of all sizes from 1 to 5000 kilowatts, in both self-cooled and water-cooled types, for either 60 or 25 cycles and for any voltage as high as 66,000.

We have on hand at all times a large number of standard transformers in sizes as large as 50 kilowatts for intermediate voltages—larger sizes can be furnished promptly.

Our catalog and literature will describe more in detail our complete line.

You will find our prices, propositions and delivery attractive.

A list of your requirements sent to the above address will be appreciated.

66000 Volt Power Transformers.

ARMSTRONG CORK & INSULATION COMPANY

125—24th STREET, PITTSBURGH, PA.

BRANCH OFFICES IN ALL THE LARGE CITIES

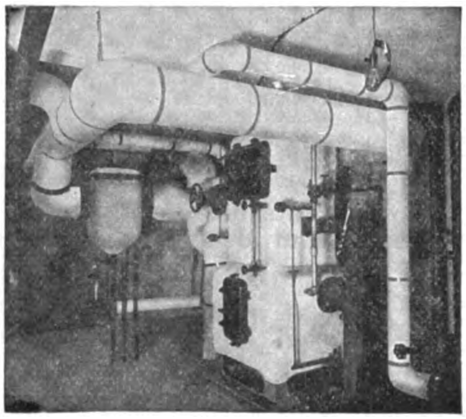
Products and Service

Nonpareil High Pressure Covering for high pressure and superheated steam lines, boilers, etc.; Nonpareil Insulating Brick for furnaces, ovens, kilns, boiler settings, etc.; Nonpareil Cork Covering for brine, ammonia and ice water lines and tanks; Nonpareil Corkboard Insulation for cold storage plants.

Contractors for heat and cold insulation.

Nonpareil High Pressure Covering

Nonpareil High Pressure Covering is made of diatomaceous earth (kieselguhr) and a small quantity of asbestos fibre for a binder. Diatomaceous earth is practically pure silica, being composed of the skeletons of microscopic plants that grew in the sea ages ago. It is estimated that there are 39 billion of these shells to the cubic inch, each one hollow and filled with air, and it is this large amount of entrapped air which gives Nonpareil High Pressure Covering its remarkable heat insulating value.



Nonpareil High Pressure Covering on steam lines and feed water heater

Advantages

Compared with other coverings, Nonpareil High Pressure Covering is not only a better nonconductor of heat, but will withstand much higher temperatures without calcining or disintegrating. It is particularly well suited, therefore, for the insulation of superheated steam lines, enameling and japanning ovens, and other places where relatively high temperatures are encountered. Moreover, it will bear repeated wetting and drying without injury, and for this reason is an ideal form of covering for underground steam lines and those which come in contact with excessive moisture.

Service Details

Nonpareil High Pressure Covering is made in sectional and block form of various thicknesses, and is also supplied as plastic cement.

Literature

Full information regarding Nonpareil High Pressure Covering is given in an 84-page bound book, which, together with samples of the material, will be cheerfully sent on request.

Nonpareil Insulating Brick

Nonpareil Insulating Brick, are also composed principally of diatomaceous earth (kieselguhr), and here again the remarkable heat insulating properties of this material are utilized to excellent advantage. For many years there has existed a real need for an insulation that could be used for reducing the amount of heat lost by conduction and radiation from boiler settings, steam drums, furnaces, ovens, hot blast mains, etc., and Nonpareil Insulating Brick meet these requirements more nearly than any other form of insulation yet put on the market.

Advantages

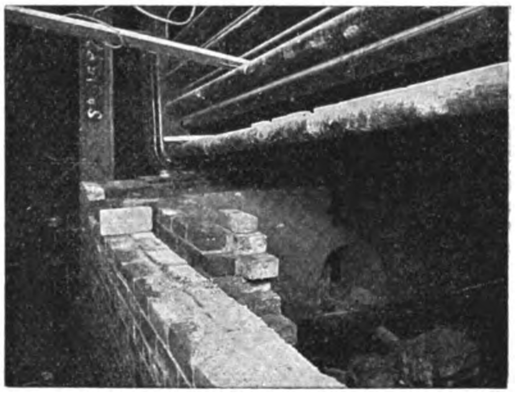
Not only are Nonpareil Insulating Brick excellent nonconductors of heat, 10 times more efficient than fire brick and common brick, but they also have structural strength and the ability to withstand relatively high temperatures. Their convenient brick form makes them easy to install in walls and arches, where the courses of Nonpareil Brick may be bonded with fire brick or common brick.

Service Details

The standard, straight Nonpareil Insulating Brick are nominally 9 x 4½ x 2½ inches and weigh about 1½ lbs. each. Various other shapes for arches, circles, etc., are carried in stock. For the purchaser's protection each brick is stamped with the trade-mark "Nonpareil."

Further Information

Literature, prices, full size sample brick, and complete information will be furnished on request.



Insulating a boiler setting with Nonpareil Insulating Brick. The Nonpareil Brick are placed between the inner courses of fire brick and the outer course of common brick

Nonpareil Corkboard Insulation

Nonpareil Corkboard is the world's standard cold storage insulation. Composed entirely of pure, granulated cork, compressed and baked, it has the lowest heat conductivity of any insulating material on the market. It is supplied in sheets 12 inches wide, 36 inches long and 1, 1½, 2, 3, 4 and 6 inches thick.

Literature

The 152-page, illustrated book, "Nonpareil Corkboard Insulation," gives full information and specifications covering all applications of Nonpareil Corkboard. A copy of the book and a sample of the material will be sent, free of charge, on request.

National Valve & Manufacturing Co.

Cable Address: "Navco"
Western Union Code.

General Office and Works
PITTSBURGH, PA.

Branch Offices
CLEVELAND CHICAGO INDIANAPOLIS

Manufacturers, Contractors, Power Pipe Materials

Products and Services

Iron and Steel Gate Valves, Fittings and Flanges; Pipe Bends; Welded Header Lines and Fabricated Pipe Work.

Installation of all classes of Piping Systems.

Co-operative Services

Personal attention and supervision of all work; supplying of special charts showing engineering data on saturated and superheated steam; curves giving sizes for steam headers and boiler connections for horse-powers 200 to 10,000, gauge pressures 125 to 300 pounds, velocities 3,000 to 12,000 feet per minute.

APPROXIMATE LOSS FROM STEAM PIPE LEAKS EQUIVALENT TO GIVEN CIRCULAR OPENINGS UNDER AVERAGE CONDITIONS.

Basis: Cost of one (1) H. P. per year of 300 days and 24 hours per day is 38.40.

Gauge Pressure of Steam In Pounds.

Dia. of Opening.	125 Lbs.	150 Lbs.	175 Lbs.	200 Lbs.	250 Lbs.
1-16"	$ 47.00	$ 55.30	$ 63.60	$ 72.60	$ 89.30
1-8 "	186.00	221.00	255.00	286.00	356.00
3-16"	423.00	500.00	578.00	648.00	800.00
1-4 "	756.00	880.00	1020.00	1140.00	1420.00
5-16"	1175.00	1395.00	1600.00	1755.00	2220.00
3-8 "	1550.00	1980.00	2280.00	2580.00	3190.00
7-16"	2300.00	2725.00	3150.00	3520.00	4360.00
1-2 "	3000.00	3530.00	4080.00	5020.00	5660.00
5-8 "	4680.00	5520.00	6360.00	7200.00	8950.00
3-4 "	6770.00	7970.00	9250.00	10330.00	12840.00
1"	12050.00	14200.00	16320.00	17300.00	22800.00

Many power plants have leaks in the various pipe connections equivalent to an opening 3-16" in diameter, which, at 175 pounds pressure, causes a loss of $578.00 per year, which is about 6% on an investment of $10,000.00. (See Chart).

National installations pay large dividends.

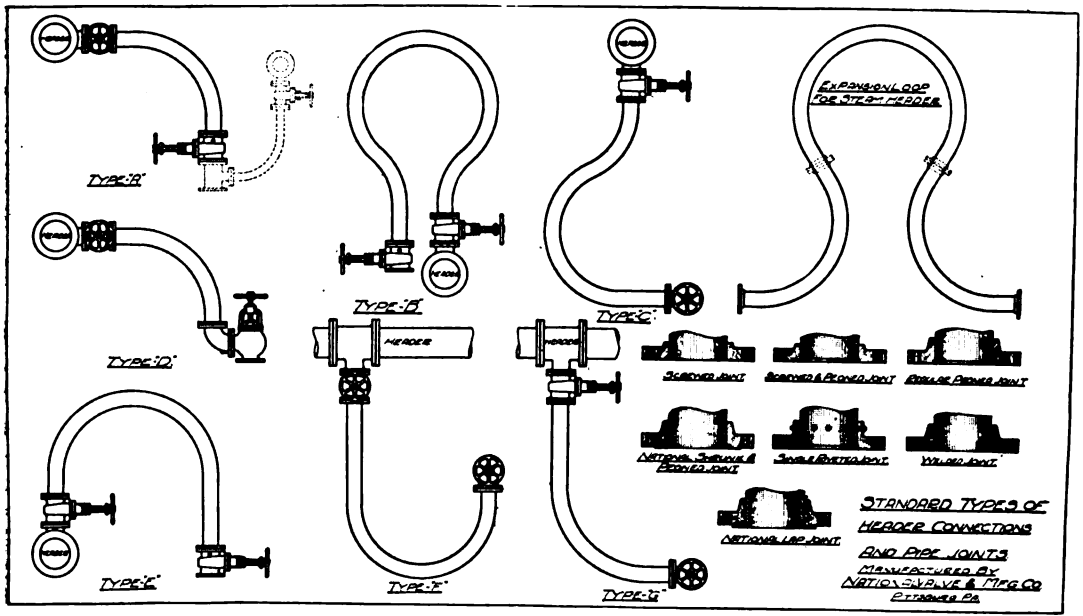


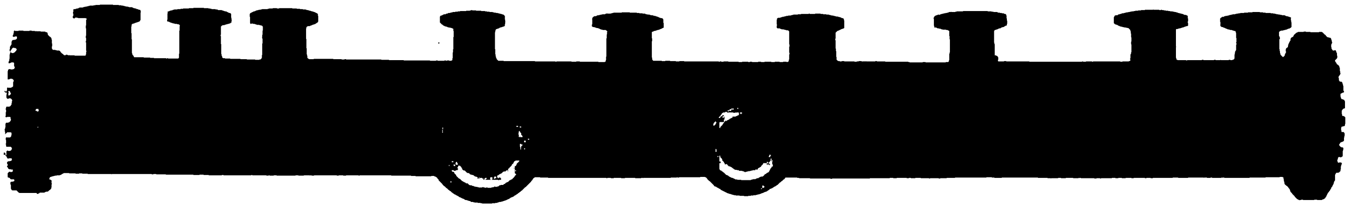
Fig. 2. Standard Types of Header Connections and Pipe Joints.

Types of Header Connections

The most approved methods of connecting boilers to header and of attaching flanges to pipe are illustrated in Fig. 2. The National square lap joint is recommended; it gives the best gasket surface, a loose or swivel flange and minimum chances for leaks.

Welded Headers

Illustration shows a 24" header with welded nozzles of extra heavy pipe, instead of flanged tees. Companion flanges are attached by means of National Square Lap Joints. In this header 13 joints are eliminated.



24-Inch Header, Nine 8-Inch Nozzles, One 10-Inch Nozzle and One 12-Inch Nozzle.

Westinghouse Traction Brake Company

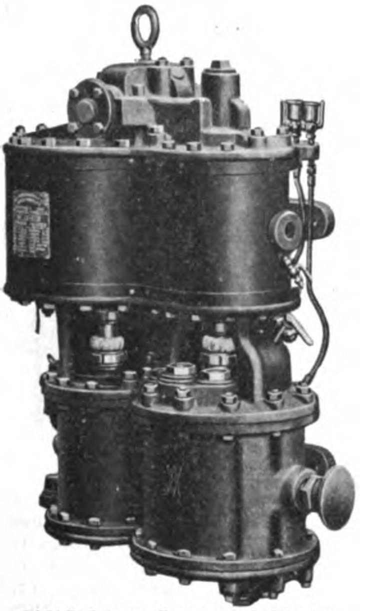
WILMERDING, PA.

Offices:

Atlanta ....Chandler Building
Boston ....Exchange Building
Chicago ....Railway Exchange Building
Columbus.......Columbus Savings and Trust Building
Denver ....Tramway Building
Houston, Texas......................4809 Main Street
Los Angeles.................Pacific Electric Building
Mexico City, Mexico....4a Puente de Alvarado, No. 100
New York....................City Investing Building
Pittsburgh ....Westinghouse Building
St. Louis...................Boatmens Bank Building
St. Paul..........................Endicott Building
Salt Lake City....................McIntyre Building
San Francisco ....Pacific Building
Seattle ....Securities Building
Topeka.......................New England Building

Coal Operators and Contractors

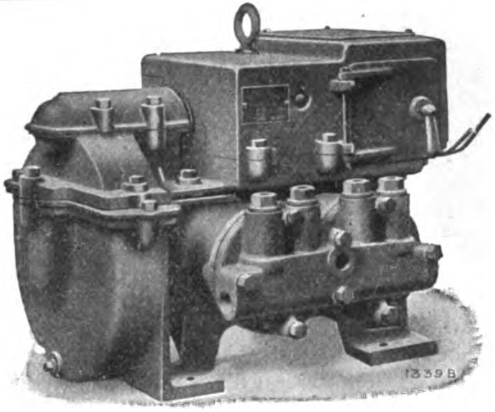
Have found Westinghouse Compressors ideally adapted to the mining industry. Built especially for the railroad brake service, these compressors necessarily embody extreme simplicity in design, absolute reliability in action, durability, compactness, efficiency and low maintenance expense. Combined with these features these machines possess a neat, attractive appearance, occupy little floor space, and may be installed at a minimum cost. Being automatic in operation, they require practically no attention.



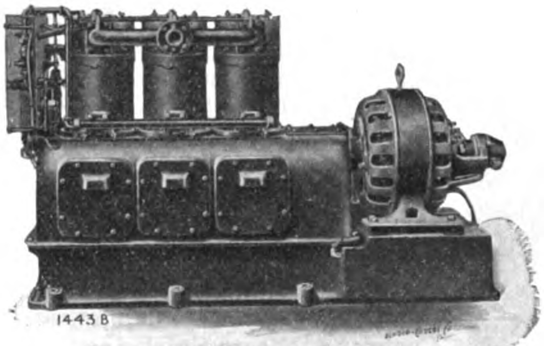
10½" Cross Compound Steam Driven Air Compressor.

Steam Driven Air Compressors

Are furnished in both the single stage and cross compound types. Standard single stage compressors are built in 8", 9½" and 11" sizes, although to meet special conditions these compressors may be equipped with various size air cylinders. The 10½" Cross Compound Compressor is especially endorsed as having large air capacity and high efficiency and economy in steam consumption.



Type "H" Motor Driven Compressor with D. C. Motor.



3-VS Motor-Driven Compressor with A. C. Motor.

General Dimensions, Displacement and Weight of Westinghouse Standard Steam-Driven Air Compressors.

	8-Inch	9½-Inch	11-Inch	10½-Inch Cross-Compound
Diameter of Steam Cylinder	8 inches	9½ inches	11 inches	H. P. 10½ inches L. P. 16½ inches
Diameter of Air Cylinder	8 inches	9½ inches	11 inches	H. P. 9½ inches L. P. 14½ inches
Length of Stroke	10 inches	10 inches	12 inches	12 inches
Governor	1 inch	1 inch	1¼ inches	1½ inches
Diameter of Steam-admission Pipe	1 inch	1 inch	1¼ inches	1½ inches
Diameter of Steam-Exhaust Pipe	1¼ inches	1¼ inches	1½ inches	2½ inches
Diameter of Air Admission Pipe	1¼ inches	1½ inches	1½ inches	2½ inches
Diameter of Air-Delivery Pipe	1¼ inches	1¼ inches	1¼ inches	1½ inches
Rated Speed, single strokes per minute	120	120	100	131
Displacement at rated speed	35 cu. ft.	49 cu. ft.	66 cu. ft.	150 cu. ft.
Over-all Dimensions	42 5/16"x17¾"x13¾"	42 5/16"x18¾"x14 5/16"	51 5/16"x21½"x15 13/16"	56 13/16"x41 13/16"x21"
Net Weight	450 pounds	550 pounds	1000 pounds	1800 pounds
Weight, boxed for shipment	550 pounds	650 pounds	875 pounds	2150 pounds
Lift of Air Valves—Suction	3/32 inch	3/32 inch	3/32 inch	3/32 inch
Discharge	3/32 inch	3/32 inch	3/32 inch	3/32 inch
Intermediate	...	...	...	⅛ inch

Motor Driven Compressors

Such as illustrated, need little introduction, since they are designed after the well-known street car type, the motor being connected to compressor by means of herringbone gear and pinion. They are entirely self-contained units, automatically controlled, efficient, reliable, and economical to operate and maintain. These characteristics have contributed to their entry in almost every industry, and especially the coal fields, where they are used on tipples, in repair plants, mines, etc. They may be furnished for either intermittent or continuous duty, for stationary or portable service, and with either direct or alternating current motors.

Type "H" for Intermittent Service. All Others for Continuous Service.

Motor Compressor	Piston Displacement, Cu. Ft. per min. at 90 lbs. pressure.	Size of Cylinder in Inches.	Crank Shaft R. P. M.	Motor R. P. M.	H. P. at 90 Pounds Pressure.	Dimensions in Inches. Length.	Width.	Height.	Approximate Shipping Weight, Pounds.
H-1	11	5 x 2½	194	1350	1.75	26¼	20¼	19⅛	630
H-2	16	5 x 4	176	1400	2.6	26⅛	26⅜	22⅜	860
H-3	20	6½ x 3	173	1100	3.5	31⅝	23⅛	22½	1090
H-4	28	6½ x 4¼	173	1250	5	31⅜	29 3/16	24⅞	1300
H-5	35	7½ x 4	172	1175	6.25	35 13/16	26⅝	25⅜	1450
H-6	50	8½ x 4	188	1100	9.25	38 11/16	26⅝	25½	1800
E-2	60	8½ x 4	226	1325	11	63¾	23¾	39½	2500
E-3	75	8½ x 6	188	1100	13.5	67¼	25½	45½	3000
3VS-11	100	7½ x 9	145	860	18	87⅞	30	49	5000
3VS-21	150	8½ x 9	170	860	27	93	33	50½	6200
3VS-22	225	9¾ x10¾	161	860	40	107	38½	60	9000
3VS-23	300	11⅝ x11⅛	146	860	54	120¼	40½	62⅜	12500
3VD	550	11 x11⅛	150	700	100	135	48	92	16000

Belt Driven Compressors

Are also supplied for either intermittent or continuous service in capacities ranging from 4 to 75 cu. ft. per minute, and for pressures up to 350 lbs. per sq. in.

Accessories

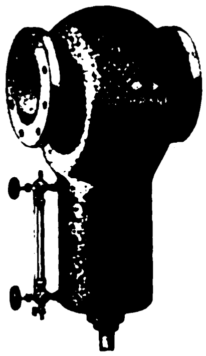
Include compressor stands, governors for automatic control of compressors, cut-out cocks, gages, reservoirs, switches, steam valves, etc.

HARRISON SAFETY BOILER WORKS

3130 N. 17TH STREET, PHILADELPHIA, PA.

Manufacturers

The Celebrated Cochrane Line



Oil Separator.

Cochrane Oil Separators

For purifying exhaust steam from engines and pumps, so that it can be used for heating, low-pressure turbines, etc. See publication, "Cochrane Separators, Their Design, Types and Uses."

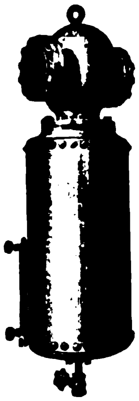
Cochrane Steam Separators

For protecting pumps, engines and turbines against water, reducing steam consumption, insuring better cylinder lubrication with less oil, and protecting the turbines against erosion of blades. Horizontal, vertical and angle types. See our book on "Cochrane Separators, Their Design, Types and Uses."

Steam Separator.

Cochrane Receiver Separators

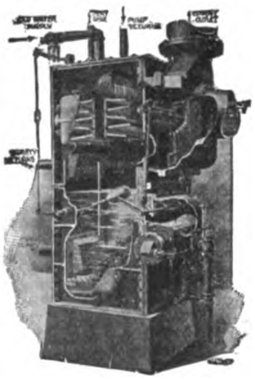
For reducing vibration and pulsation in the steam lines, raising the average pressure in the steam chest, and for getting along with smaller steam lines and fittings. These separators have an ample well, both to receive large doses of water, and to supply steam storage close to the engine throttle.



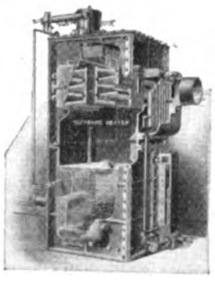
Receiver Separator.

Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver

For use in connection with exhaust steam heating or drying systems, combining the functions of feed water heater and independent separator for purifying the exhaust steam used in the radiators and coils. The separator is made large enough to purify all of the exhaust steam available, and valves are provided by means of which the body of the heater can be cut out of circuit for inspection or cleaning while the separator continues in operation. Commercial exhaust steam heating systems are described, with useful tables and data, in our "Exhaust Steam Heating Encyclopedia."



Steam-Stack and Cut-Out Valve Heater and Receiver.



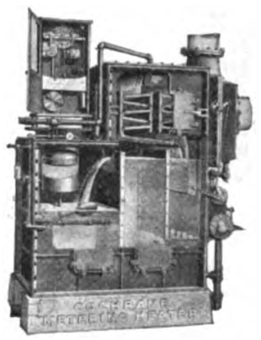
Open Feed-Water Heater

The Cochrane Open Feed Water Heater

Saves 10% to 15% of the fuel or increases the steaming capacity in the same ratio by utilizing exhaust steam to heat the feed water. It also protects the boiler against temperature strains, drives off air and gases in the water and provides a hot well and an automatic raw water regulator. See our catalog on "Cochrane Heaters for the Profitable Utilization of Exhaust Steam."

The Cochrane Metering Heater

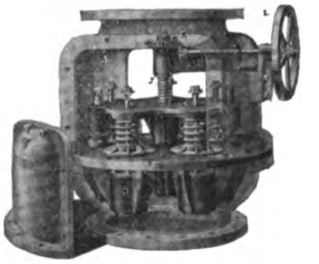
Shows how many pounds of steam are evaporated by a pound of coal, making it possible to determine the best kind of coal to use, how much it pays to clean scale and soot off tubes, the best methods of firing or draft control, the effects of stopping up air leaks, etc. It performs all the functions of the standard Cochrane Heater, and besides accurately meters the water. See our book, "Finding and Stopping Waste in Modern Boiler Plants."



Metering Heater.

The Cochrane Multiport Valve

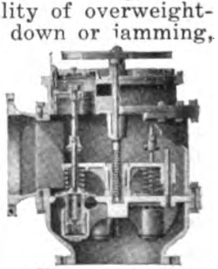
Protects the exhaust steam system against excessive rise of pressure, and invaluable in conjunction with heating or drying systems or condensers. A number of disks instead of one large disk reduce weight and travel, and hence the tendency to hammer, which is eliminated altogether by an effective dash-pot for each disk. There are no moving parts connected to the disk extending outside the casing, hence no possibility of overweighting, tying down or jamming, as by overtightening of packing glands. See our book on "Multiport Valves, Their Types and Uses."



Multiport Valve.

The Cochrane Multiport Flow Valve

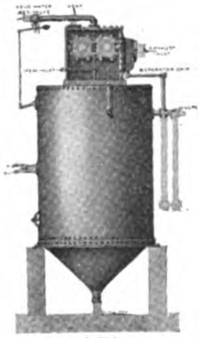
Prevents vacuum backing up through the mixed flow turbine to the engine exhaust line and thereby drawing in air, to the detriment of the vacuum. Explained in the "Multiport Catalog."



Flow Valve.

The Sorge-Cochrane Hot Process Water Softener

Protects the boiler against scale and corrosion, and keeps out sludge and sediment, while at the same time securing all the advantages of heating the water to the maximum temperature. No independent feed water heater is required. Due to the use of heat, smaller apparatus is required than with the cold process, and it can usually be installed in the boiler room without special foundations, which at the same time lessens the cost of piping and connections. See our new publication, "Hot Soft Water for Steam Boilers."



Steel Plate Softener.

COCHRANE ENGINEERING SERVICE

For twenty-five years our organization has devoted itself to the **profitable utilization of exhaust steam.** We have made a specialty of utilizing exhaust steam for heating water for boiler feed and other purposes, and for heating buildings, drying materials, operation of low pressure turbines, etc., also of the softening and metering of water. Our skill and experience are at your service, with no further expense to you than the writing of a letter detailing your present conditions and the making of a simple sketch showing your present layout. Even if you have no pressing problem demanding solution, you may obtain valuable suggestions from the Cochrane literature, as mentioned under the different headings above.

FRANK L. PATTERSON & COMPANY

26 Cortlandt Street
NEW YORK

Manufacturers of

HOT WATER HEATERS

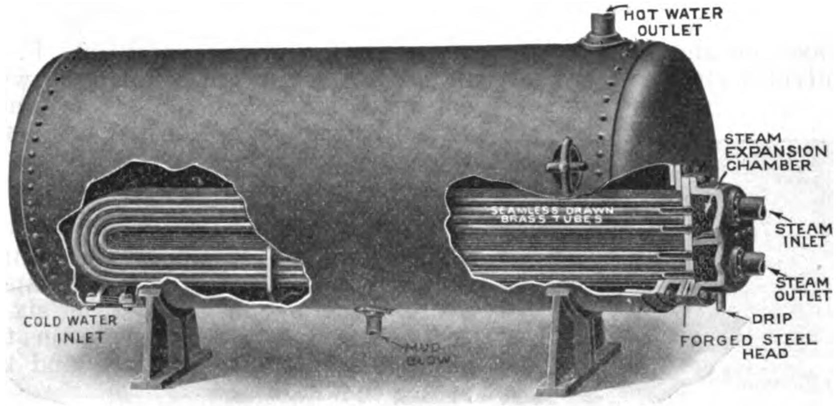
For Wash Houses

Products

Patterson-Berryman Feed Water Heaters and Purifiers, Patterson Hot Water Heaters, Patterson Steam and Oil Separators, Patterson Exhaust Pipe Heads, Komo Steam Traps.

Patterson "∩" Tubes

A brass tube 12′ long will expand sufficiently to increase its length ¼″ as its temperature changes from 50° to 210°. The former temperature is about that of the incoming water and the latter that of exhaust steam at atmospheric pressure. Hot water heater tubes are therefore constantly changing in length and in any group there are individual tubes that are expanding more rapidly than others in the same group. This is due to the varying temperatures of the water in contact with them. There is, therefore, no uniformity of action in this expansion and each tube **must** be so shaped that it can expand and contract freely and independently of any other tube. The "∩" shape is the only absolute provision for taking up this unequal expansion and contraction and preventing leaking.



Patterson Combined Hot Water Heater and Storage Tank

The heater illustrated above combines an efficient hot water heater and a storage tank in one apparatus. The shells are of heavy boiler plate provided with standard manholes. The heating surface consists of "∩" shaped seamless drawn brass tubing, both ends of each tube being expanded into the heavy tube head. The tube head and tubing may be removed for cleaning or examination by simply unbolting from the head of shell.

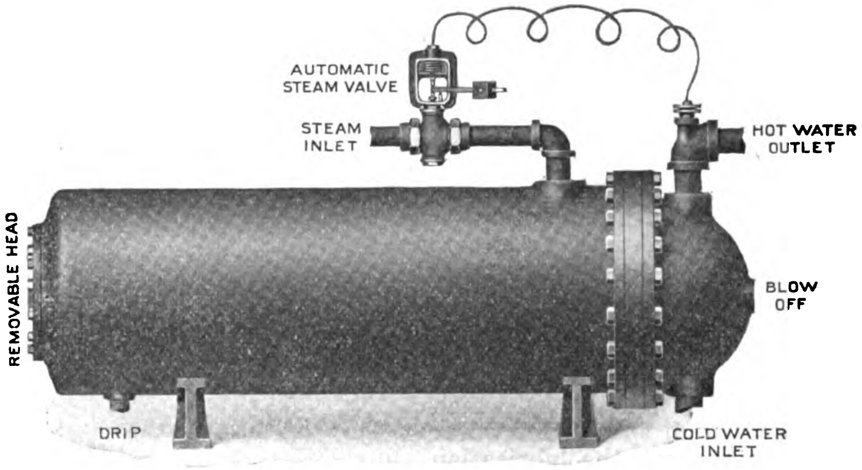
Showers or lavatories are as a rule not in constant use and therefore the storing of hot water for the heavy pull means less steam consumption than if the water is heated as used.

Ample storage capacity is provided for this purpose and the water is gradually heated either with exhaust or live seeam and a supply thus provided for instant use.

The Patterson Instantaneous Hot Water Heater

This heater is adapted to installations where the demand for hot water is practically constant. The shells are of cast iron or boiler plate. The heating surface is of "∩" shaped seamless drawn brass tubing as in our Combined Hot Water Heater and Storage Tank. Both types of heaters can be furnished with automatic temperature control valves to regulate the temperature of the water and decrease steam consumption.

We have had a wide experience in heating water for miners' wash houses and are prepared at any time to place this experience at the disposal of those interested without any obligations. If you contemplate the erection of a wash house let us suggest the proper heater and method of installation and operation.



POWER SPECIALTY COMPANY

111 BROADWAY, NEW YORK CITY

BOSTON, PHILADELPHIA, PITTSBURGH, CHICAGO, SAN FRANCISCO

Steam Superheaters and Special Heating Apparatus

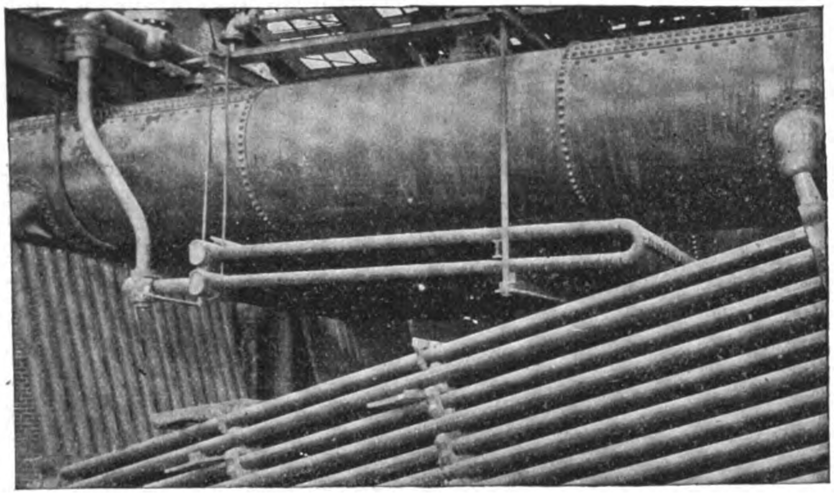
Products

Steam Superheaters of all types:—

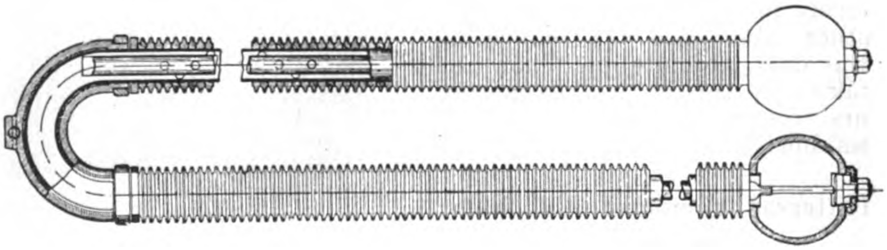
For installation in the setting of any type of boiler; in separate setting with direct firing; waste-heat type; marine superheaters; locomotive superheaters; portable superheaters, with coal, oil or gas firing and special designs for process work. Heaters for air, oil and gas of standard design also of special construction to meet new requirements.

Superheated Steam

Steam as generated in a boiler always contains a certain amount of water in a finely divided state and when this steam passes through steam lines, into cylinders of engines, turbines, etc., condensation rapidly takes place. Thus in addition to the steam which actually produces the power, there is also present a large quantity of hot water which does no work. This is a great loss not only from the fact that fuel was required to heat the water but also because its presence causes excessive wear to turbine blades, valves and all portions of the machinery which it passes at high speed. Hot water also tends to wash the lubrication from cylinder walls and valves, thus reducing the effectiveness of the lubricant and shortening the life of the machinery. Superheated steam contains absolutely no water and has the form of a perfect gas. Superheated steam will pass down long steam lines and into cylinders or turbines giving up superheat slowly and without any condensation until all of the superheat has been given up through radiation.



Foster Superheaters in the setting of Babcock & Wilcox water-tube boilers at the Readville, Mass. Power House of the N. Y., N. H. & H. R. R.



Cross section of return bend element and connecting headers used in Foster Superheaters.

Thus when the conditions of a steam plant are known, it is a simple matter to superheat the steam so that it will arrive at any given point either perfectly dry or so superheated that the maximum efficiency can be obtained from the machines in which it is utilized.

In general it may be stated that 100° F. of superheat will effect a saving, in comparison with saturated steam, of 10% in turbines, 12% in triple expansion engines, 14% in compound engines and 18% or more in simple engines.

Foster Superheaters cover the widest possible range of temperatures going as high as 1200° F. final temperature. Fuel savings vary from six to forty per cent, depending upon the character of the installation and the steam conditions.

Construction

The material and design of Foster Superheaters are the result of many years' successful manufacturing and are the best known at the present time. All parts subject to steam pressure are of steel, which gives maximum strength, and all parts exposed to hot gases of combustion are cast iron, thus insuring longest possible life. Steel tubes are covered with cast iron rings and give the most desirable combination, a patented principle not obtainable in any other apparatus. Several million horsepower of these superheaters are in use all over the world and plants operating in every industry give the best opportunity for determining the results obtained.

THE SIMS COMPANY

ERIE, PA.

BRANCH OFFICES AND AGENCIES

Guy L. Andrews, 1215 Loraine St., Pittsburgh, Pa.
Huntington Supply & Equipment Co., Huntington, W. Va.
B. W. Thurtell, 22 Quincy St., Chicago, Ill.
Manufacturers Sales Co., 255 N. 12th St., Philadelphia, Pa.
Mine & Smelter Supply Co., Denver, Colo.
Henry M. Fife, 1111 Holland Bldg., St. Louis, Mo.
Earl F. Scott, Candler Bldg., Atlanta, Ga.
Moore-Handley Hardware Co., Birmingham, Ala.
C. J. Moulton, Room No. 745 Marbridge Bldg., New York City

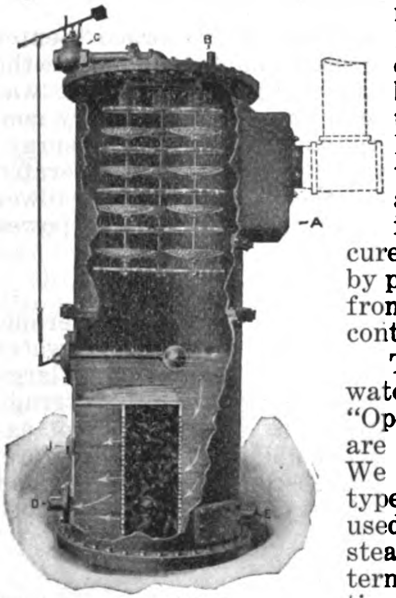
Manufacturers of Power Plant Appliances

Products

Feed-Water Heaters, Steam Separators, Exhaust Heads, Oil Filters, Etc.

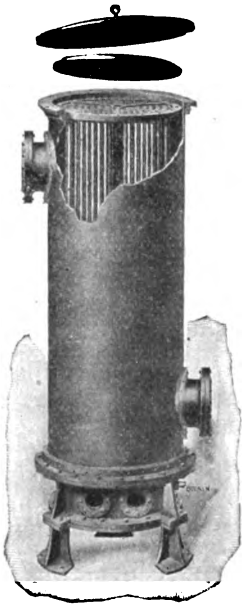
Feed-Water Heating

The value of a feed water heater as a fuel and boiler saver need no longer be argued. **Every 11 degrees of heat saved by using exhaust steam represents a saving of 1 per cent of fuel,** or the increase of boiler capacity to the same extent. Large increase in the life of the boiler and large reduction in repairs are secured at the same time by prevention of strains from expansion and contraction.



Open Type.

Two types of feed-water heaters—the "Open" and "Closed"—are generally known. We manufacture both types. The kind to be used in any particular steam plant must be determined by local conditions. Design and construction of our heaters are the outcome of many years' experience in the manufacture of steam appliances. The most exacting and scientific engineers will recognize them as thoroughly up-to-date, representing the highest type of engineering and manufacture—the product of the best material, the latest tools, and the most skilled workmen. Our works are situated at a good distributing point, assuring the most favorable rates of freight.



Closed Type.

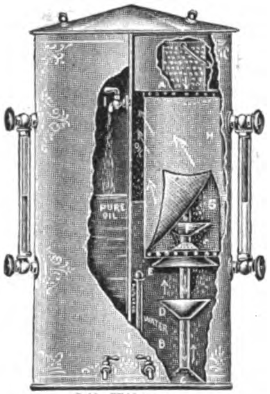
Sims Open Feed-Water Heater Filter and Purifier

Renders the additional service of removing earthy matter, carbonate of lime, and similar impurities. Made round, to resist accidental or occasional back pressure; of cast-iron, which is not subject to corrosion; with every part accessible for cleaning. Perforated saucers suspended from bolt hooks give excellent distribution of the water, either through the perforations or in a thin veil around the edge, thus enabling the water to absorb every possible unit of heat from the incoming steam.

Filtration is cross-current through coke, with automatic float regulation and overflow trap. Blowing down the mud chamber reverses the water current and automatically cleans the filter. A vent pipe at the top may be carried back to the exhaust or elsewhere so the heater cannot become air-bound. An oil separator of scientific construction entirely prevents carrying over any grease. A hand hole and blow-off connection are provided in the mud chamber; water gauge and thermometer are supplied with each heater. Listed in 14 sizes, 50 to 4,000 horse power, larger sizes as may be required.

Oil Filters

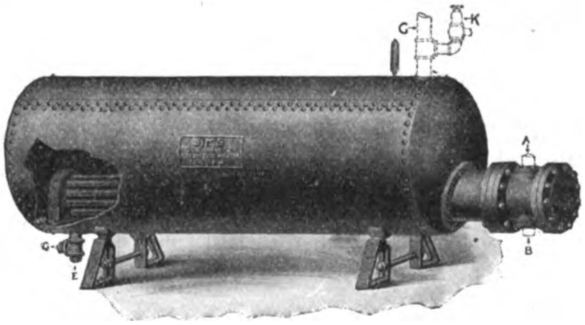
Oil costs good money—saving fifty or sixty per cent on the lubricating oil used in the engine room, would be quite an item—it can be done by investing a small amount in a Sims Filter—get our circular showing sizes and filtering capacities. Send in your order for a 30 days trial—we know it will stay.



Oil Filters.

"Clean E-Z" Heaters for Miner's Wash House

Take a bath before leaving the mine property—Required by law in many States. When providing suitable wash houses and facilities for the comfort of employees, use a Sims Storage Type "Clean E-Z" Heater—as illustrated—made in sizes and heating capacity to suit any conditions. Tell us what you need, number of gallons per hour, steam pressure, exhaust or live steam, and we will submit a proposition with guarantee of satisfactory service. If you have a storage tank, we can furnish a circulating generator to connect with it. Write us!



"Clean E-Z" Heaters For Miner's Wash House.

SPRAY ENGINEERING CO.

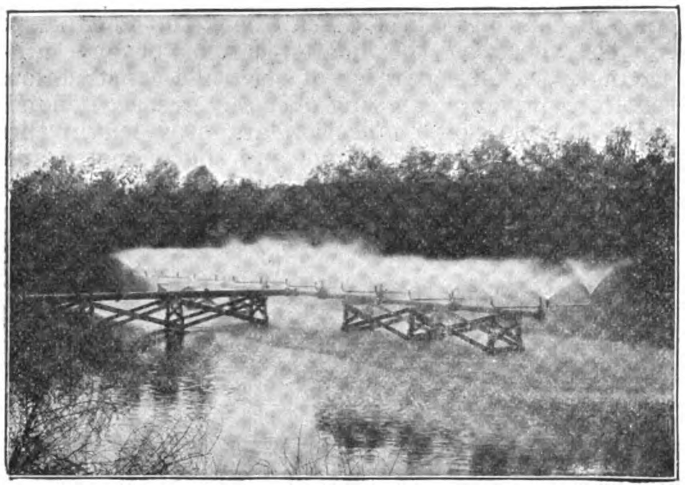
ENGINEERS--MANUFACTURERS

93 Federal Street
NEW YORK BOSTON CHICAGO

Spray Cooling Systems

General

The Spraco Cooling System is the simplest, most economical, and efficient device in existence for cooling water used in condensers, water jackets, transformers, evaporators, and other equipment where the conservation of the water supply is essential.



Advantages

The principal advantages of a spray system over a cooling tower are: Lower initial and maintenance cost; greater saving in power required for operation; longer life; reduction in make-up water requirements, and greater flexibility.

Cooling Capacity

The hot water delivered to the system is cooled by spraying through specially designed nozzles, producing a finely divided spray at low pressure. The cooling is effected by evaporation, radiation, and convection, the water falling into an artificial or natural pond, sufficiently reduced in temperature, to permit of its being used over again. Under average hot weather conditions, the temperature of the cooled water will approximate the temperature of the air, and in the hottest summer hours will be from 2 to 6 degrees F. lower than the surrounding air.

Economy

With the introduction of steam turbines, better vacuum and therefore colder condensing water has become a necessity. By increasing the vacuum in steam turbines from 26 to 27 inches, the average gain in fuel economy is about 5%. Similarly, by increasing it from 27 to 28 inches, a further gain of about 6% will result, and the next one-half inch more of vacuum will improve the efficiency about 4% more. This means that a total improvement of 2½ inches of vacuum above 26 inches will save approximately 15% less of the steam used in turbines of good design. By the use of the Spraco system, it is possible to obtain an average vacuum of 28 inches in nearly all parts of the United States.

Power Requirements

By reason of improvement in our Spraco "Center Jet" nozzles, we have been enabled to reduce the power to operate sprays fully 50% of what was formerly thought necessary. Under ordinary conditions, the power necessary to operate the sprays will average less than 1½% of the power generated by the engine, whereas the average cooling tower will require for operation about 3% of the power generated.

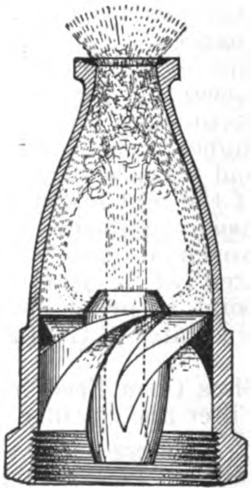
Water Loss

Where pure water is scarce, its loss is a serious matter, and it is the economy in the use of water that has recommended our system to many large power plants. Tests have shown that the average yearly loss of water with our system will not exceed 1½% of the condensing water. Therefore, the addition of the condensed steam to the pond supply where jet condensers are used will more than make up the water losses.

Spraco "Center Jet" Nozzles

The Spraco nozzle is the most important feature of the cooling system. Its function is to produce a fine uniform spray at low operating pressure without clogging. As seen in the illustration, the nozzle is provided with removable turbine center. The centers are held stationary in the nozzles, and the water in passing through is given a rapid rotating motion. A **central driving jet,** which impinges on the rotating water at the orifice, causes the water to be ejected in a fine, dense, uniform spray.

A special bulletin on this subject will be sent upon request.



Patented Spraco Nozzle

Other Spraco Products

- Air Washing and Cooling Equipment.
- Paint Spraying Equipment.
- Flow Meters.
- Park Sprinklers.
- Nozzles for all purposes.

THE PERMUTIT COMPANY

30 East Forty-Second Street
NEW YORK,. N. Y.

BRANCH SALES OFFICES:

BUFFALO, N. Y. MINNEAPOLIS, MINN. CHICAGO, ILL. JACKSONVILLE, FLA. PHILADELPHIA, PA. DETRIOT, MICH.
LOS ANGELES, CAL. ST. LOUIS, MO. SYRACUSE, N. Y. PITTSBURGH, PA. KANSAS CITY, MO.
BOSTON, MASS. HAMILTON, ONT.

Iron Removal and Water Softening Apparatus

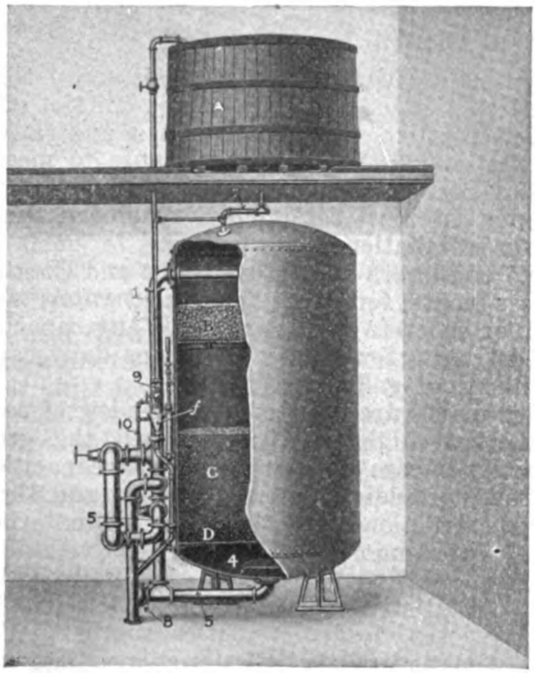
Permutit

Products

Complete water rectification apparatus for iron removal and water softening; also for the removal of other minerals, suspended matter, color, objectionable odors, gases and tastes.

Iron Removal Apparatus

"Permutit" Iron Removal Apparatus is specially designed to meet the conditions of each case. It may be either of the pressure or the gravity type, as circumstances may indicate, and involve either chemical or simply mechanical processes, as each case may require. The exceptional results secured are due to this extreme care in the preliminary investigations and in the specific design of apparatus based upon the factors thus determined in each case. "Permutit" Apparatus is simple and rugged in construction, easily operated, and absolutely certain in its results. It embodies the observations of a wide and diversified experience, and has been developed to a point where the iron removal is complete and absolute. The automatic delivery of "free-from-iron" water is guaranteed.



A Permutit Water Softening Filter.
A—Salt Solution Tank.
B—Upper Layer of Gravel.
C—Layer of Permutit.
D—Lower Layer of Gravel.

Water Softening Apparatus

"Permutit" Water Softening Filters use no chemicals, but work by simple filtration of the water through a filter bed of an artificial exchange silicate, which has the unique faculty of removing every trace of lime and magnesium no matter how the percentage of these materials in the water may vary. Over-treatment or under-treatment of the water—which constitute the most serious objection to chemical types of softeners—is absolutely avoided. "Permutit" Filters deliver an unvarying supply of water of absolute "zero hardness". After the filter has delivered its guaranteed quantity of soft water, it can be regenerated—restored to its original condition ready for renewed softening—by treatment with a solution of common salt. "Permutit" softened water is the ideal feed water for boilers, absolutely free from all scale-forming substances. Its use cleans boilers, lowers fuel consumption, eliminates boiler cleaning, lowers repair and replacement costs.

Guarantees

"Permutit" Iron Removal Apparatus is guaranteed to deliver water perfectly clear, free from turbidity, and so free from iron that it will not grow cloudy on standing.

"Permutit" Softening Filters are guaranteed to deliver water of "zero hardness", absolutely free from lime and magnesium—the common hardening and incrusting salts.

In General

It is obviously impossible to present in detail the various types and arrangements of "Permutit" Water Rectification Apparatus. The Company will, however, undertake to treat any water in a simple and efficient manner and to rectify it to a condition suitable for any purpose. Descriptive literature, sketches and estimates will be furnished on request—a sample of the water to be treated being desirable in all cases as a basis for recommendations.

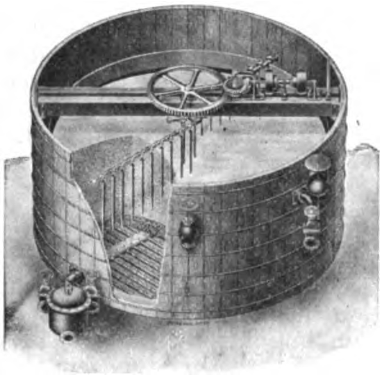
PITTSBURGH FILTER MANUFACTURING CO.

GENERAL OFFICE, PITTSBURGH, PA.
Branch Offices, Kansas City, Mo.

Pressure and Gravity Filters, Water Softening Plants

Description of Pittsburgh Gravity Filters

These filters are built in sizes from five to twenty feet in diameter, when built of wood, or constructed of steel, but are usually built of rectangular shape when constructed of concrete. They are most suitable for small cities, hospitals, public institutions, paper mills or other industrial purposes where considerable quantities of water are required.



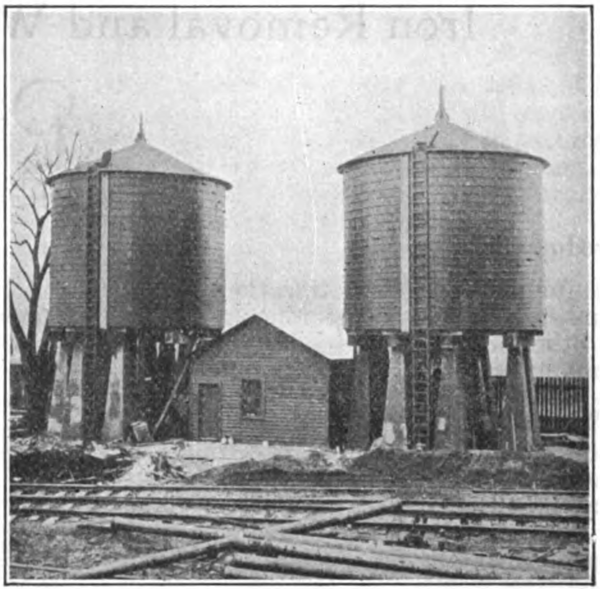
Gravity Filter.

They are equipped with the best type of gate valves, controlling the inlet, outlet, and wash-water supply. The inlet is supplied with a controlling float valve to regulate the supply to filter, and the outlet controlled by an automatic rate controller when required.

We build these filters equipped with the standard rake agitator operated by gears and belts or with our system of air agitation as may be most convenient or desirable. With our system of air-wash the air may be used at the same time as the wash-water or independently, as desired.

We build this filter in the belief that it is the most perfect in design and construction, simplest in operation, most efficient in results of any of its type on the market.

Prices on application.



Intermittent Water Softener.

Types of Plant

We build several different types and designs of plants, each having their peculiar points of advantage for certain conditions. Our long and varied experience enables us to design plants to meet any peculiar local conditions, embracing such features as will give the most satisfactory results at the least cost for installation and operation.

We build both the Intermittent and Continuous Process plants, for either hot or cold water, of steel, wood, or concrete construction, of any capacity required from a few thousand gallons daily capacity to millions of gallons.

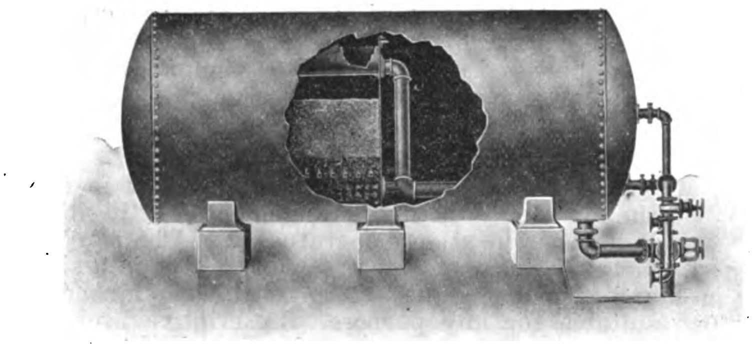
Our plants are designed with a view of combining the very highest efficiency with the greatest simplicity in care and operation. Our capacities are generous, providing ample elasticity and the construction of the best type of material and workmanship of their respective kinds.

If you desire a plant for Railroad Water Station use, industrial or municipal purposes, do not fail to consult us. We will make analysis of your water and recommend the type of plant best suited to your needs.

Concrete now so generally used in the construction of municipal plants is becoming more and more the standard of permanent construction.

We are prepared to design and construct both the intermittent and continuous type of plant in concrete.

We build but one kind—The Best.



Pressure Filter.

WM. B. SCAIFE & SONS COMPANY

FOUNDED 1802

PITTSBURGH, PA.

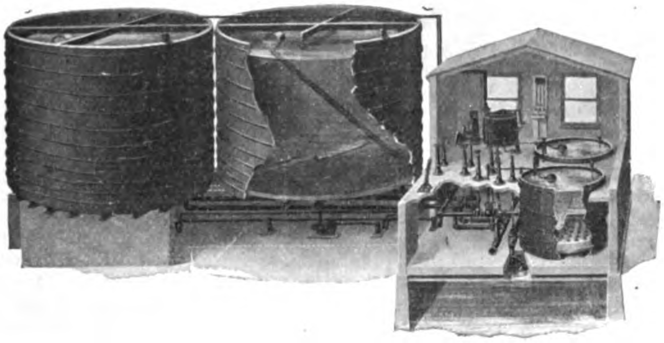
Water Purification for All Purposes

Softening and Filtration Systems

Our Water Purifying Systems are designed to meet the specific requirements of each case. We guarantee definite results and specialize in furnishing apparatus for purifying water for boiler feed and domestic use with a single installation meeting the requirements of State Boards of Health.

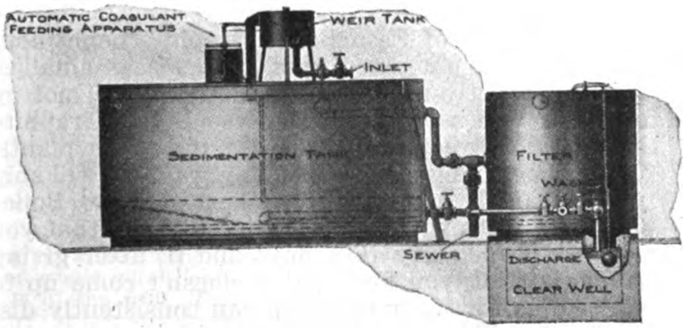
The WE-FU-GO System (Intermittent).

In this system measured quantities of water are treated, therefore accuracy of treatment can be maintained and a uniform soft and clear water obtained, regardless of either the impurities in the raw water supply, or the variations in its quality, and the rate at which the purified water is used. This system meets every requirement for the perfect neutralization of acids, and the softening and clarification of water for both boiler feed and domestic purposes. The reaction and settling tanks act as storage tanks, in which a very considerable volume of water is carried that is available for irregular demands. There are no complicated mechanisms or adjustments, and the system can be efficiently operated with common labor of ordinary intelligence.



Mechanical Gravity Filters

These filters are of the open tank type built in suitable units for any desired capacity. A complete mechanical gravity filter system includes an automatic coagulant feeding device, sedimentation tank, filter completely equipped, a rate controller on outlet from filter, a loss of head gauge on filter, and in special cases necessary apparatus for introducing a sterilizing reagent. These filters are adapted for all conditions requiring only removel of iron and suspended matter or bacterial purification.



Syphon System (Continuous)

An automatic system not dependent upon moving mechanical devices for reagent introduction. The water entering the system flows into a receiving tank to which is connected a syphon; into the long leg of which are connected small syphons which introduce the reagents in direct proportion to the discharge of the main syphon. The harmonious action of these syphon de--pends only upon the periodic rise of the water to the same height in the syphon tank and emptying to a fixed depth; therefore its accuracy is not affected by the rate at which the water enters the system.

An efficient filter to insure perfect clarification is included; this filter is washable without contaminating the water in the settling tank.

This system can be arranged to operate from the ground or on top, and can be modified for special requirements.

Pressure Filters

These filters are designed to operate with water under pressure and are built in suitable sizes for any desired capacity and pressure. They are usually built vertical in sizes up to 96 inches diameter, for large capacities they are built horizontal. These filters are adapted for the clarification of water, for offices, dwellings, swimming pools, etc., where space is limited.

Some Coal Mine Installations

Consolidation Coal Co., Jenkins, Ky.
J. H. Sanford Coal Co., Raccoon, Pa.
Carnegie Coal Co., Oakdale, Pa.
Northwest Coal Co., Simpson, Pa.
United Coal Corp., Meadowlands, Pa.
Oak Ridge Coal & Coke Co., Hastings, Pa.
Pittsburgh & Baltimore Coal Co., Wendell, Pa.
Fayette Coal Co., Noblestown, Pa.
New River & Pocahontas Cons. Coal Co., Minden, W. Va.
Keystone Coal & Coke Co., Madison, Pa.
Pennsylvania Coal & Coke Corp., Cresson, Pa.
B. F. Berry Coal Co., Standard, Ill.
Atlantic Crushed Coke Co., New Derry, Pa.
United States Coal & Oil Co., Holden, W. Va.
Youghiogheny & Ohio Coal Co., Wyano, Pa.
Allegheny River Mining Co., Seminole, Pa.
Vinton Colliery Co., Vintondale, Pa.
Ford Collieries Co., Curtisville, Pa.
West Kentucky Coal Co., Sturgis, Ky.
W. J. Rainey, Uniontown, Pa.
Consolidation Coal Co., Acosta, Pa.
Pittsburgh Coal Co., Jacobs Creek, Pa.
The Provident Coal Co., St. Clairsville, O.

THE S. OBERMAYER CO.

PITTSBURGH CHICAGO CINCINNATI

Manufacturers of

Boiler and Lubricating Graphite

Products.

Esso Boiler Graphite, Perfection Lubricating Graphite, Foundry Facings and Supplies.

Esso Boiler Graphite.

Is a scale preventive. You will never know its worth until you know its value.

Fifty years of grinding Graphite for all purposes have developed our Esso Boiler Graphite. Esso Boiler Graphite is non-corrosive and is not acted upon by acids ar alkalies. Esso Boiler Graphite is a pure amorphous grade ground and air floated to an exceptional fineness and guaranteed to prevent scale from forming. It is used as per directions given below:

Directions For Using Esso Boiler Graphite.

Before using Esso Boiler Graphite clean your boilers thoroughly and add one quart of Graphite for 100 horse power developed when filling your boilers.

For daily treatment feed in one pint of Esso Boiler Garphite for 100 horse power developed.

Conditions govern the amount added materially and in many cases these quantities may be reduced. Esso Boiler Graphite should be fed directly into the boiler, either through an injector or by pass on suction side of feed pump. It should not be thrown into tanks or hot wells as it will settle if the water is not agitated. To obtain the best results, stir quantity desired for daily use in receptacle filled with hot water and begin introducing this mixture after getting under way. Esso Boiler Graphite can be fed through ordinary compound feeders if same have impulse from pump or steam agitator.

Where conditions warrant it may be fed through the heaters as this method keeps the heater clean and reduces oil consumption as well as increasing the life of pump packing.

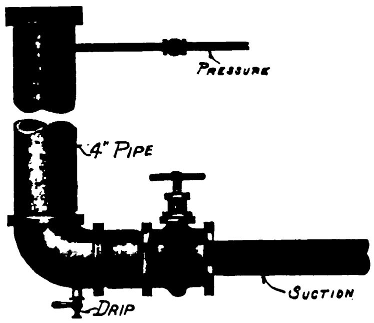
Boilers should be blown down two gauges of water daily and more frequently if condition of water requires it.

For painting drum tubes, etc,, with Esso Boiler Graphite mix about two-thirds of Esso Boiler Graphite with boiled Linseed or Carbon Oil, adding a small quantity of Litharge. Mix to a consistency of paint. After cleaning steam drums thoroughly coat them with above mixture. This will give you an initial coating for your tubes, which will prevent pitting. Then add your quart of Graphite as stated before.

Boilers should be opened about once a week for about the first 12 weeks after using Esso Boiler Graphite to investigate results.

Feeding Device.

The feeding device herewith illustrated will be found to be all this is required. When the 4-inch pipe is being charged with graphite it should be half full of water. The graphite should then be thrown into a chamber and more water poured on top until the pipe is full. Afetr the tank is closed the lower valve is opened a little and the upper one just cracked. If the boilers are in a battery, care should be taken that each boiler receives its share of graphite.



COMPLETE TABLE OF AMOUNTS COVERING BOILER TREATMENT WITH ESSO BOILER GRAPHITE

For Boinler.	Gallons Water Evap. in 10 Hrs	Daily Quantity of Esso to be used.
100 H. P.	4,000	8 oz.
150 " "	6,000	12 oz.
200 " "	8,000	16 oz.
250 " "	10,000	20 oz.
300 " "	12,000	24 oz.
400 " "	16,000	32 oz.
500 " "	20,000	40 oz.
600 " "	24,000	48 oz.
700 " "	28,000	56 oz.
800 " "	32,000	64 oz.
900 " "	36,000	72 oz.
1000 " "	40,000	80 oz.
1200 " "	48,000	96 oz.
1600 " "	64,000	128 oz.
2000 " "	80,000	160 oz.
2400 " "	96,000	192 oz.
3000 " "	120,000	240 oz.
5000 " "	200.000	400 oz.
8000 " "	320,000	640 oz.
10000 " "	400,000	800 oz.

On account of Esso Boiler Graphite being non-corrosive and not acted upon by acids ar alkalies, it has a strictly mechanical action and will not go out of boilers and renders. Esso Boiler Graphite is particularly adaptable to coal mine power plants.

Without obligating you in any way, we will ship you a barrel, half barrel or keg of Esso Boiler Graphite, with the distinct understanding that you can use it for sixty (60) days and if, after giving it a fair trial, you find that it doesn't come up to our claims for it, or that you can consistently dispense with it and still maintain a high standard of efficiency, the unused portion can be returned at our expense and no charge will be made for materials used in making test.

Sterling Equipment and Supply Co.

245 Race Street
PHILADELPHIA, PA.

Manufacturers of

"Sesco" Vegetable Feed Water Treatment

A Scientific Product Honestly Marketed

In discussing this subject let us consider the fact that practically every water supply available for boiler use contains certain mineral substances in amounts varying from one grain to two hundred grains per gallon. The most common of these, and the ones that cause the greatest trouble, are the carbonates and sulphates of lime and magnesia. These substances are non-volatile, and every gallon of water evaporated from the boiler leaves behind its mineral contents, either precipitated by boiling or forced out of solution by the increasing concentration of these salts in the water remaining in the boiler. **The serious factor** in this process of precipitation is the fact that under the high temperature and pressure existing in the boiler these minerals are deposited in a solid crust on the inner surface of the shell or tube. Continuous deposits under these same conditions soon build up a lining on the heating surface that is as hard as stone, with a power of resisting heat transmission over half of that of asbestos.

The average water supply will carry about twenty grains per gallon of encrusting solids. Assuming a power plant of 150 H. P. evaporating close to 5,000 gallons daily, we can readily calculate that each day will see about one and one-half pounds of scale-forming material left behind it to do its work. In bad waters this may be as high as ten pounds per day. Thus in the average practice it is obvious that a sixty days' run will involve the precipitation of not less than ninety pounds of scale-producing solids, and in less favorable cases as much as six hundred pounds. **Picture the appalling loss of heat efficiency** that must result from surrounding the water contents of the boiler with a shell of heat-insulating material from an eighth to one-half inch in thickness. Reputable fuel engineers have figured heat losses as high as 50 per cent., due entirely to boiler scale.

Another thing to contend with is the possibility of the water carrying free acid, alkali, carbonic acid gas, or chloride of magnesia. Any of these will corrode the boiler shell and produce pittings that will eventually ruin the boiler.

We now come to the consideration of methods used to combat these ever present evils, scale and corrosion.

The oldest method, and one still much in vogue, is the use of chipping tools and cleaner to rid the boiler of its burden of scale. This can only be done when the boiler is out of service. Therefore, we can assume a boiler starting on a run absolutely clean. When the time comes that even with a maximum of fuel, steam cannot be kept up the boiler is again taken off and cleaned. The net efficiency of that particular boiler lies midway between its work in its best and in its worst condition. Since it frequently requires 20 per cent. more fuel at the end of the run than at the beginning, it is obvious that there has been an average waste of 10 per cent. of fuel during the whole run. Add to this an estimate of the **damage done to the boiler by chipping** and the loss sustained by having it out of commission for cleaning, and you can readily figure what boiler scale costs such a plant.

Another method is the external purifier, usually depending on a treatment of the pre-heated feed water with lime and custic alkali, either by double treatment or a combination of the two. This involves constant supervision to secure proper treatment and to avoid getting any excess of either of the chemicals used, which condition would be harmful to the boiler. Furthermore, there is to contend with the difficulty of securing a complete precipitation of the impurities at the comparatively low temperature at which it is treated. **Consider then the cost of cleaning the filters** and maintaining the system, and the **interest charges** on the **high cost of installation,** and you have an idea of the price to be paid for external treatment.

The last method to be considered is the use of an internal treatment, the function of which is to precipitate the scale-forming impurities within the boiler in such a granular condition that the particles will neither adhere to each other nor to the inside of the boiler, thus permitting them to be discharged as a sludge or mud on the daily blow-off.

When a treatment will properly perform this function it is not only a successful preventative, but also an economical one.

A bad feature, and one that has tended more than any other to bring boiler compounds into disrepute, is the tendency of many manufacturers to load up their compounds with inert and useless materials that only serve to give them weight. In some cases this has been carried to such a point that it makes the compound an absolute fraud. No compound, or treatment whatever it may be, should be suffered to enter the boiler until passed upon by a competent chemist as to its alkalinity, acidity and complete solubility in water. Even then it should not be used until an analysis of the water shall demonstrate that it is suited to the treatment for which it is intended.

We have made a study of this subject for a long time and have finally achieved a treatment that not only embodies all the good features of compounds, but eliminates the evils. By a **combination of certain materials** of purely vegetable origin with an absolutely neutral mineral salt **we have been able to make a boiler feed water treatment** that is **neither acid** nor **alkaline,** that will not foam or prime, nor corrode the boiler or piping; and that will absolutely prevent pitting and the formation of scale and remove scale already present. **It does not corrode or dissolve the scale already present, but will penetrate it and disintegrate it, separating it from the metal** and permitting it to be flushed out of the boiler. In short, it is a **treatment that will do the work** and do no harm, one that makes our clients as enthusiastic as we are, when they join the ranks of users of a treatment that has never yet failed.

The Sterling Equipment and Supply Company, in marketing this feed water treatment, known as "SESCO," have constantly adhered to certain business principles which have made their business a success.

Firstly—Every new customer is supplied with a treatment that is exactly suited to their individual requirements. An anaylsis of this water supply is made by one of the best-known chemists in this line in the east. From this analysis we prescribe the exact amount of each ingredient necessary to do the work, and the treatment is made exactly in accordance with the requirements of this analysis.

Secondly—Should the analysis show that a water is such that it will not lend itself to successful treatment, the business will not be handled at any price.

Finally—No new customer is asked to pay his first bill until a reasonable trial has convinced him of the truth of all claims made for the treatment.

In short, "SESCO" Boiler Feed Water treatment is devised to give a square deal to both the customer and the boiler, and to fill a want that will exist as long as our industrial world continues to produce its necessary power by the generation and application of steam.

W. E. CALDWELL CO. INC.

Main Office and Works
2220 Brook St. Louisville, Ky.
Manufacturers of

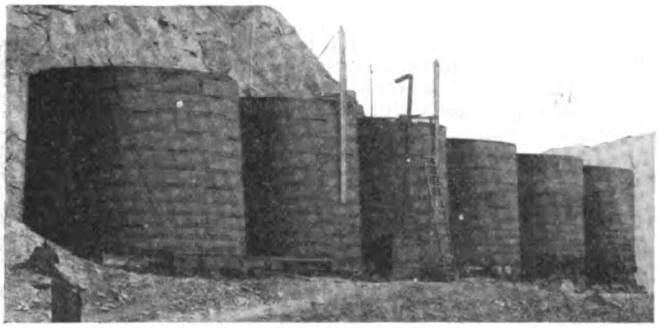
Caldwell TANKS AND TOWERS

Caldwell FRICTION CLUTCHES

Wood and Steel, Tanks and Towers, and Power Transmission Machinery

Products

Wood, steel and galvanized tanks for all purposes; tubular, angle or channel column steel and wood towers; railroad fixtures, water supply systems; Friction Clutch pulleys, gearing and general power transmission machinery.



Stonega Coal & Coke Co., Stonega, Va.

Wooden Tanks

We specialize in Cypress, as it is the best tank wood for most purposes and especially so for tanks exposed to the weather. It has great durability with minimum shrinkage and swelling and gives no taste or coloring to drinking water. We also use Yellow Pine, White Pine, Cedar and Fir.

Specifications

Lumber—Thoroughly dry, without loose or unsound knots, splits, shake, peck or worm holes or other defects. All heart on inside, sound sap on outside only, not to exceed one-half the thickness.

Thickness—2 in. for 10,000 gals. and smaller; 2½ in. up to 20,000 gals.; 3 in. for larger sizes. The finished thicknesses are 1¾, 2½ and 2¾ in. respectively.

Standard Inside Diameter—Every 6 in. from 3 ft. to 9 ft., every foot to 16 ft. and every 2 ft. above 16 ft.

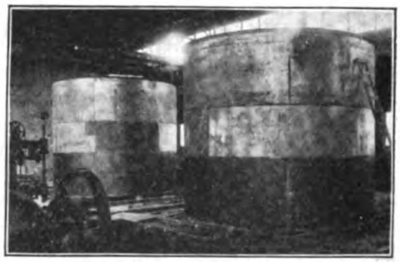
Standard Inside Depth—1 ft. 5 in.; 2 ft.; 2 ft. 5 in.; 3 ft.; 3 ft. 5 in.; 4 ft.; 4 ft. 5 in.; 5 ft. 5 in.; 6 ft. 5 in.; 7 ft. 5 in.; 9ft. 5 in.; 11 ft. 5 in.; 13 ft. 5 in.; 15 ft. 4 in.; 17 ft. 4 in.; 19 ft. 4 in.; 21 ft. 4 in.; 23 ft. 4 in.

Workmanship — Staves dressed both sides. Edges machine jointed to proper bevel. Bottom dressed on top side only. Machine jointed straight and square and well doweled.

Hoops—Round hoops of wrought iron (not steel) with malleable iron draw lugs, sizes and spacing to give a safety factor of 4 to 1.

Steel Tanks

Thin Galvanized tanks are recommended only in small sizes and for intermittent or temporary use.



100,000 and 30,000 Gallon Tanks for Crozer Coal & Coke Co. and Page Coal & Coke Co.

Heavy steel tanks are made in any shape or size. The standard diameters and depths are in even feet. The standard thicknesses are ⅛ in. up to and including 10 ft. diameter; 3-16 in. up to 16 ft.; ¼ in. and 5-16 in. above 24 ft.

We furnish these set up in smaller sizes or knocked down, all punched, fitted and bent to shape with the necessary rivets.

Foundations

Foundations for tanks are very important. Poor foundations are very often the cause of leakage. Plans for foundations on the ground will be furnished. Designs of, and prices on, foundations for special conditions will be submitted on receipt of a sketch with full dimensions.

Consolidated Coal Co., Staunton, Ill.

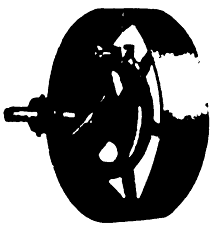
Tank Towers

Standard towers are of the following types:

Tubular Column — Class "O" to "G" 15 ft. high and every 12 ft. interval above 15 ft.

Augle Column — Classes "CC" to "LL" 12 ft. high and every 10 ft. above 12 ft.

Latticed Column—Classes "LD" to "LH" and Hemispherical Bottom Steel tanks and towers every 5 ft. from 20 ft. up.



Caldwell Friction Clutch

The Caldwell Clutch is exceptionally simple and strong.
One lever controls it.
One screw adjusts it.

STANDARD SIZES

Capacity Gals.	Standard Wood Tanks Diam.	Standard Wood Tanks Depth	Standard Galv. or Steel Tanks Diam.	Standard Galv. or Steel Tanks Depth	Capacity Gals.	Standard Wood Tanks Diam.	Standard Wood Tanks Depth	or Steel Tanks Standard Galv. Diam.	or Steel Tanks Standard Galv. Depth
1,000	6'6"	4'5"	6'0"	5'0"	20,000	16'0"	13'5"	16'0"	14'0"
1,500	6'6'	6'5"	6'6"	6'6"	22,000	16'0"	15'5"	16'0"	16'0"
2,800	8'0"	7'5"	8'0"	7'0"	25,000	16'0"	17'4"	16'0"	18'0"
3,000	8'0"	8'5"	8'0"	8'0"	30,000	18'0"	15'4"	18'0"	16'0"
5,000	10'0"	9'5"	10'0"	8'0"	33,000	18'0"	17'4"	18'0"	18'0"
6,000	10'0"	11'5"	10'0"	10'0"	35,000	18'0"	19'4"	18'0"	20'0"
10,000	12'6"	11'5"	12'0"	12'0"	36,000	19'6"	17'4"	20'0"	16'0"
12,000	12'6"	13'5"	12'0"	14'0"	40,000	19'6"	19'4"	20'0"	18'0"
15,000	14'0"	13'5"	14'0"	16'0"	50,000	22'0"	17'4"	22'0"	18'0"
17,000	14'0"	15'5"	14'0"	16'0"	55,000	22'0"	19'4"	22'0"	20'0"

SOME OF OUR CUSTOMERS ARE:

Lehigh Valley Coal Co., New York and Pennsylvania.
H. C. Frick Coke Co., Pittsburgh, Pennsylvania.
Western Coal & Mining Co., St. Louis, Missouri.
Consolidated Coal Co., St. Louis, Missouri.
Consolidation Coal Co., Fairmont, W. Va.
Island Creek Coal Co., Holden, W. Va.
Lorain Coal & Dock Co., Columbus, Ohio.
Chicago & Cartersville Coal Co., Chicago, Illinois.

American Steam Gauge & Valve Mfg. Co.

Main Office and Works

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Branch Offices

NEW YORK CHICAGO PITTSBURGH ATLANTA

Products

Gauges—Both Indicating and Recording for Steam, Water, Air, Oil, Gas, Hydraulic, Ammonia and all other pressures; also Vacuum and Compound.

Gauge Testers, Engine Room Clocks, Revolution Counters.

Pop Safety and Relief Valves, Steam Whistles, Globe, Angle and Check Valves, Engine Indicators, Feed Water Regulators, Feed Water Grease Extractors, Steam Traps, and Blow-Off Valves.

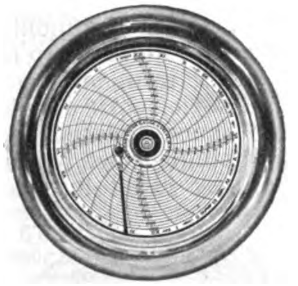
American Gauges

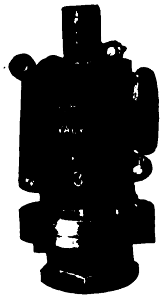
are the simplest in construction, yet so designed that maximum efficiency with longest service is assured to the user.

Gauges are too often judged or selected from superficial inspection only, with little or no attention to interior construction—the VITAL PART. In AMERICAN GAUGES only the best material and workmanship will be found, as well as accuracy. This means dollars in every sense of the word to the owner in both operating and maintenance expense. We furnish gauges for every purpose, and especially invite inquiries for installations where operating conditions are unusually severe. Estimates promptly furnished.

American Recording Gauges

The economical operation of power is safely guarded by the use of accurate, durable Recording Gauges. AMERICAN RECORDERS are constructed in the same reliable, workmanlike manner that is characteristic of all our products. The style of case is the same as our non-recording instruments, thus giving uniformity to gauge board installations. Highest grade clock movements are used, insuring accurate time records. Standard chart 8 inch, 24 hours. Special charts to order. Each gauge fitted with our improved fountain pen requiring filling monthly. We specialize in engine room gauge boards complete, and invite inquiry.





The American Pop Safety Valve

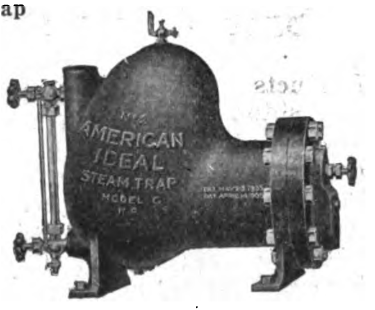
for stationary and marine boilers—fitted with American adjustable-blow-down ring—all adjustments from outside easily accessible. Few working parts. Best material and workmanship. Durable and economical in operation. Made to meet all requirements.

American-Thompson Improved Indicator

The original Thompson Indicator. The highest grade instrument of this kind on the market. New improved Detent Motion makes it possible to take several cards in less time than for one by the old method. Special catalog covering all details on request.

American Ideal Steam Trap

Model C—Regularly furnished for all pressures up to 250 lbs. Has patented valve leverage which permits use of heaviest guaranteed floats, and at the same time has much greater capacities at all pressures. Specify your traps on CAPACITY BASIS only and get FULL VALUE.

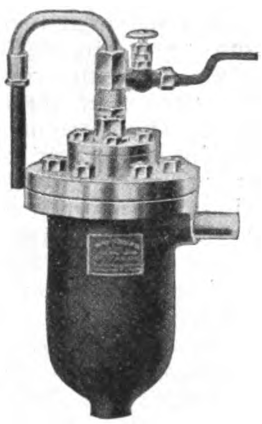


Send for DATA booklet.

The American H2O Grease Extracting Feed Water Filter should be installed in every plant where condensation is used for boiler feed. This practical device makes it impossible for oil to get into the boiler, thus preventing bagging plates, oil caked tubes and danger. It keeps the heating surface clean—increases steaming capacity—and lowers coal bills. Well constructed—has filtering surface equal to many times the area of the feed water pipes—has a device for applying a reverse current of steam for temporary cleaning.

Renewals are easy to make—every part is easy to get at—and the maintenance cost is practically nothing.

The American Thermofeed Regulator:



Maintains water level at fixed height.

Increases boiler efficiency and increases life of boiler.

Reduces expansion and contraction strains of boiler plates.

Reduces strains of rivets and seams.

Protects boiler from danger of "low water."

Send for complete descriptive matter.

Howard Improved Ball Valve

Particularly designed for Blow-Off Valve, but suitable for water, air, oil, gas, beer, etc.

All Bronze—cannot corrode.

Self-wiping and cleaning seat.

Has full area of pipe line.

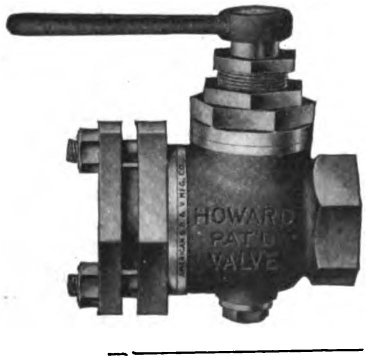
Opened or closed with quarter turn.

The greater the pressure the tighter the valve.

It is adjustable to take up wear.

Tested to 1000 pounds Hydraulic pressure.

Guaranteed for 300 pounds working pressure.



THE ASHTON VALVE COMPANY

Main Office and Works
161 First St. Cambridge C., Boston, Mass.

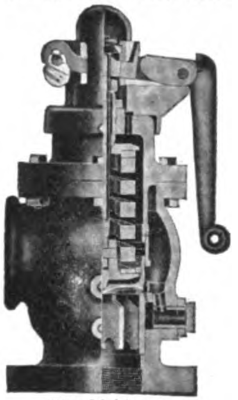
Branches
New York, N. Y., 128 Liberty Street
Chicago, Ill., 608 So. Dearborn Street
Pittsburgh, Pa., Park Building.

Safety and Relief Valves, Pressure and Vacuum Gages

Products

Ashton Pop Safety and Relief Valves; Pressure and Vacuum Gages, both regestering and recording; Dead Weight Gage Testers; Engine Room Gage Outfits; Thermometers; Whistles; and kindred Power Plant Specialties.

Ashton Pop Safety Valves have been on the market for the past 45 years and have an established reputation for high quality, efficiency and durability. They embody the latest improvements in the state of the art and are made to give dependable service. Their special features of design are as follows: Outside screw Plug Pop Regulator; giving a positive means for adjustment of the blow-back which is always accessible and easily adjustable by means of a wrench. Knife Edge Lip Wing Valve; insuring the most steady and invariable blow back, requiring the minimum amount of adjustment on account of wear and service. Base Outlet Construction; whereby valve can be taken apart for inspection or minor repairs without dis-connecting outlet pipe. Springs: of Jessop's style, carefully made by and tested in our own factory. Compound Trip Lever; making it possible to lift the valve off its seat readily by hand regardless of what may be the boiler pressure. This lever may also be raised to a vertical position and held there, thereby serving as a means for blowing down the boiler pressure. Swivel Top Cap: With its set screw adjustment renders the setting of the lever lifting attachment at any position that may be desired. Testing Clamps: are furnished without extra charge. By their use hydrostatic boiler tests can be conducted without changing the set pressure adjustment of the valve.



No. 20 Valve.

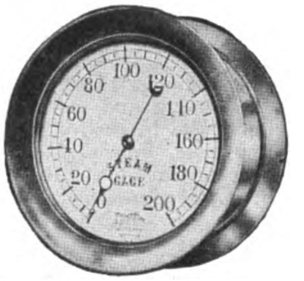
Specifications

Valve Styles: The No. 20 single and No. 20-A duplex are the regular standard for use on stationary or marine boilers with saturated steam. These valves are ordinarily made with cast iron body and all working parts of high-grade composition metal, excepting the spring which is of steel and the seat which may be either composition or nickel. For high pressure service steel bodies are furnished. The No. 17 with outside spring, steel body and solid nickel seat and wing valve is especially adapted for use of super-heated steam. All of the above styles are made in sizes from 2″ to 6″ inclusive and are suitable for pressures up to 300 lbs. maximum. For smaller service requirements composition body valves are furnished in sizes from ¾″ to 3″ inclusive. The No. 6 style with top open discharge without lever or lock-up. The No. 8 with lever and lockup and No. 9 with side pipe outlet, lever and lock-up.

Capacity Schedule

Ashton Pop Safety Valves are regularly made with moderate lift of .10″ which insures smooth operation with greatest durability and lowest cost of maintenance. When so specified, however, they are made to conform to the requirements of A. S. M. E. Boiler Code, or to comply with any state or local regulations.

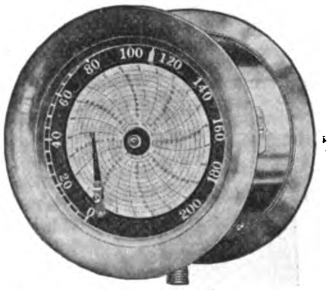
Ashton Pressure and Vacuum Gages are conscientiously made of the best material. Solid drawn seamless tubes are used. The movements are non-corrosive, having German silver pinions and arbors. Each dial is accurately and separately made to exactly correspond with the spring and movement of the gage to which it is fitted. The graduations and figures are indented, so that they can be easily read, and will not wear off. The springs are well seasoned to prevent setting.



No. 51 Gage.

The No. 51 style pressure gage is commonly used on stationary boilers, is made in all sizes up to 24″ diameter dial, and with either iron, brass or nickel plated case. The No. 52 style, with double spring, is similarly made; but more adapted for locomotive, marine or water pumping service where there is considerable vibration, or rapid fluctuation in pressure.

Recording pressure gages with 24 hour charts and graduated for any desired pressure are made in two styles, Nos. 73 and 74, and with brass or nickel plated cases. The latter is both registering and recording.



No. 74 Recording Gage.

No. 69 Illuminated Dial Gage is so constructed that an incandescent electric light may be placed behind it, and by means of a glass back the light is directed on to the ground glass dial. This is especially valuable in poorly lighted boiler rooms, or for night operation.

Other Appliances

We also manufacture standard styles of water relief and cylinder relief valves, the Ashton Approved Underwriter Fire Pump Relief Valve, Ammonia Relief Valves, Blow-Off Valves, the Ideal Alarm Gage for Sprinkler Systems, dead weight gage testers, engine room gage boards, boiler gage cocks and water gages.

THE FAIRBANKS COMPANY

Write Our Nearest Branch

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Manufacturers & Dealers

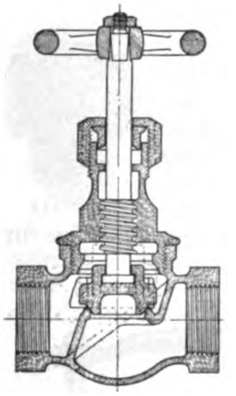
Valves and Cocks of All Kinds, for All Purposes

Products

Scales, Valves, Trucks, and Wheelbarrows, Gasoline Engines, Pumps, Ventilators, Electric Light Plants, Power Transmission Machinery, Power Hammers, Supplies.

Fairbanks Valves and Cocks

Of the many kinds of valves and cocks that we manufacture, the following are the ones most in demand for coal mines:

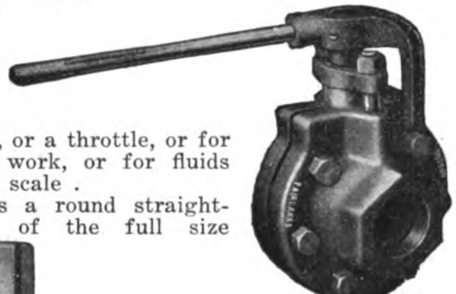


Fairbanks Brass Globe with Bevel Seat and Disc

The special feature of this valve is the renewable disc, with bevel seat. The shoulder on the upper side is also beveled, and is so arranged that when the valve is wide open, the disc seats against a corresponding bevel in the bonnet, making a tight joint and taking all pressure off the stem packing. The disc can be replaced by merely slipping it off the end of the stem, and slipping a new one on in its place.

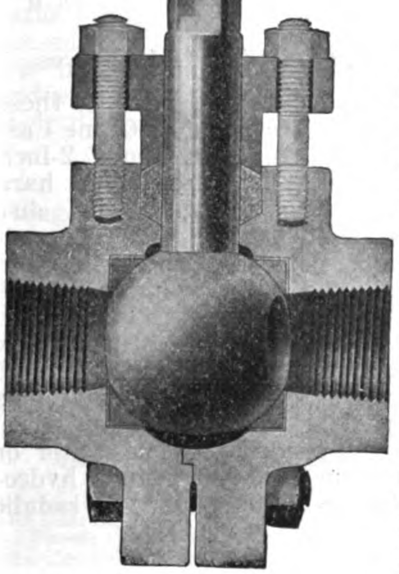
The packing nut is provided with a follower gland. The opening through the valve is the full area of the pipe.

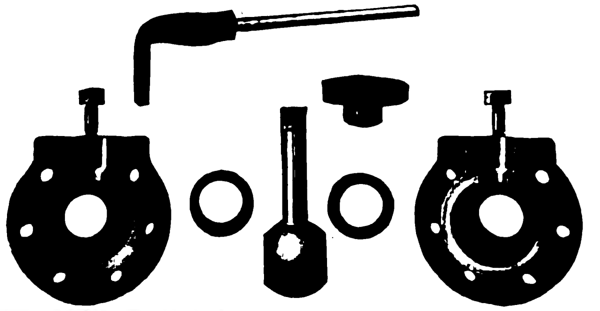
Fairbanks "Sphero" Valve

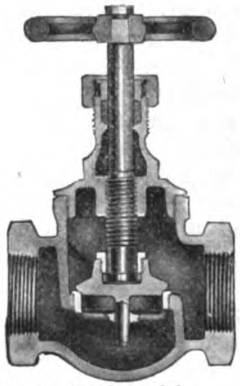


Designed to meet the need of an easily operated, quickly repaired valve or cock that can be used as a blow-off, or a throttle, or for oils or hydraulic work, or for fluids containing grit or scale.

This valve has a round straight-through passage of the full size of the pipe. All parts are interchangeable. The seats are of steel-armored Vulcabeston rings, a hard, tough, durable compound of rubber and long-fibre asbestos. It has just enough elasticity to make a perfect valve seat. These rings are fully protected when the valve is open so the wear on them is very slight, even in the presence of grit or scale. The ball plug bears only against the Vulcabeston, which is elastic enough to compensate for expansion and contraction, and prevents any tendency to bind.





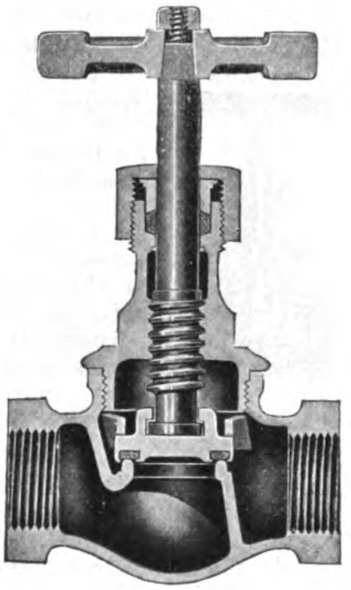


Fairbanks Brass Hub Iron Body Globe Valve

This design is heavier and more compact than many other makes of similar type. The spindle is of large diameter, the packing nut has a follower gland, and the disc seat is heavy. It is especially desirable when quality and durability are the first consideration. May be packed under pressure when wide open.

Brass Globe with Renewable Vulcabeston Ring Disc

To meet special requirements, this style of renewable disc has been designed. The disc is fitted with a ring of Vulcabeston, and when worn can easily be taken out and replaced with a new one. Discs with rings of copper, leather or other material can be used in place of Vulcabeston if desired. Thus, in addition to the ordinary renewable disc features, this type has the advantage of being adaptable to variable conditions by the mere introduction of a new disc.



Fairbanks Renewable Iron Body Gate Valves

The feature of this design is the bronze seat rings, that may be removed by the use of a suitable wrench and replaced without removing the body of the valve from the line.

The body casting is accurately machined, so the new seat rings are strictly interchangeable. A double-taper solid wedge is used, with faces of steam bronze. Pressure may be applied to either side of this valve.

This style can be furnished with either rising or stationary spindle. All parts are interchangeable. The stuffing box may be packed under pressure when the valve is wide open.

The gate by-pass is similar in design and is secured to the body of the valve by a single joint.

CRANE COMPANY

836 South Michigan Avenue, Chicago

Founded by R. T. Crane, 1855

Works: Chicago and Bridgeport

BRANCH HOUSES:

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WINNIPEG

Manufacturers of

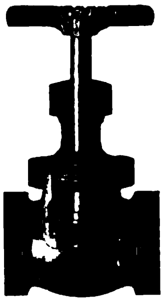
Everything for any Pipe Line

17,000 articles including valves and fittings in sizes 1/8 to 72-inch, made of brass, cast iron, malleable iron, ferrosteel, cast steel and forged steel, for water pressures up to 6,000 pounds, for steam pressures up to 400 pounds, any superheat, and for air pressures up to 2,000 pounds.

Products

Power plant specialties, fabricated pipe and bends ready for erection, pop safety valves, engine stop valves, steam traps, swivel expansion joints, steam separators, cast steel headers, pipe supports, exhaust relief valves, mine piping, pump columns, stop valves, check valves, water relief valves, flanges, bolts, gaskets, cocks for air lines, sediment traps, air safety valves, pressure regulators, expansion joints, screwed and flanged fittings, sanitary drainage fittings, long sweep water fittings and plumbing fixtures.

Regrinding Globe, Angle, Cross, Check Valves



No. 70 Globe.

These valves are made of Crane Special Brass. They are fitted with our improved non-heating malleable iron wheel and may be repacked when open and under pressure. The body is reinforced by a heavy union ring and when pressure is applied any tendency of the body to stretch is counteracted by this ring and the contact between the body and the ring becomes more intimate as the pressure increases. Tested to 250 pounds hydraulic pressure per square inch.

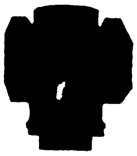
Extra Heavy Gate Valves, O. S. & Y.

These valves are made of Crane Ferrosteel with extra heavy hard metal seats which are screwed to shoulders in body, thereby insuring perfect joints. Seats can be removed at any time it may be necessary to renew them. The gate is made very stiff and is faced with hard metal. The guides in the gates are carefully finished so as to slide smoothly on ribs in the body, thus preventing any rattling when the valve is open or any uneven wear of faces. Stuffing box flange is of malleable iron with a brass follower, giving additional strength and durability at that point. These valves may be packed when open. Tested to 800 pounds hydraulic pressure per equare inch.

No. 9-E.

Mine Cocks

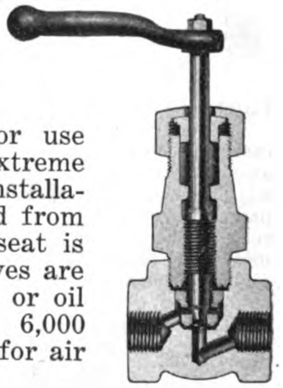
For Compressed Air Lines are tested under air pressure and are suitable for 125 pounds air pressure and 175 pounds cold water working pressure. They are made all iron, or iron with brass plug, and have good steel springs which automatically take up wear.



No. 318

Forged Steel Globe and Angle Valves

Meet the demand for a thoroughly reliable valve for use with hydraulic presses and extreme high pressure air or gas installations. The body is machined from a solid steel forging. The seat is easily renewable. These valves are recommended for cold water or oil working pressures up to 6,000 pounds hydrostatic. Valves for air or gas are special.



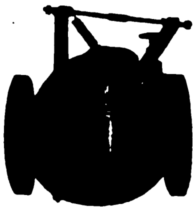
No. 225-H.

Extra Heavy Hydraulic Cast Steel Gate Valves

The bodlies, bonnets, yokes and discs of these valves are made of Crane Cast Steel. In sizes above 2-inch the disc is faced with hard metal; size 2-inch has disc in solid hard metal. The construction of the seats and method of screwing it in the body, the strength and finish of the gate and stuffing box are similar to our No. 9-E valve. Also they may be packed while under pressure. These valves are recommended for cold water or oil working pressures up to 3,000 pounds hydrostatic, and are tested to 3,000 pounds hyradulic pressure.

No. 205-D.

Crane-Erwood Automatic Double Acting Non-Return and Emergency Cut-Out Valve.



No. 36-E.

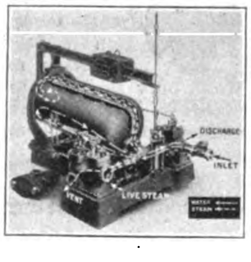
The principle duties of the Crane-Erwood Valve are boiler protection, header protection, automatic cut in, line protection. These valves are extra heavy, made of ferro-steel with hard metal seats and discs and are recommended for steam working pressures up to 250 pounds. The levers on the outside of the valve are in line with the discs and give a positive indication of their position and the operation of the valve at all times. The valve may be adjusted to close at any desired velocity. Adjustments are made from the outside while the valve is in operation.

Sediment Traps

No. 990.

For water working pressures up to 250 pounds. These sediment traps are constructed in a strong and substantial manner and will be found exceptionally valuable for use in connection with steam traps, pumps, injector and ejector suction pipes, feed water lines, etc. by preventing foreign substances from passing through and settling on valve seats and other places that should be kept entirely clear and free from such obstructions.

Cranetilt Steam Traps



Three Valve Trap.

Are designed as Non-Return, Boiler Feed, Lifting, Vacuum or Metering traps. They are especially adapted for use on return lines handling condensation under varying pressures, especially where the pressure will vary from a vacuum to high steam pressure. The Cranetilt Three Valve trap gives excellent service on returns on apparatus that has a varying pressure while in service or a low initial starting pressure and a high terminal pressure. Buy steam traps by their discharge capacity,—not by pipe sizes.

Flanged Pipe Joints

With Crane Cast Steel or Forged Steel Flanges are highly recommended for use in connection with pipe bends.

THREE STANDARD TYPES.

No. 281-D.
Screwed Joint with Cast Steel Flange.

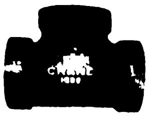
No. 295-E.
Craneweld Joint with Forged Steel Flange.

No. 181-D.
Cranelap Joint with Cast Steel Flange.

EXTRA HEAVY MALLEABLE FITTINGS:

No. 260-H.

No. 262-H.



No. 264-H.

No. 267-H.

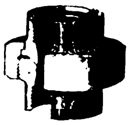
Extra Heavy Malleable Iron Screwed Fittings

The Crane line of malleable iron fittings includes all the necessary sizes and shapes for cold water or oil working pressures as follows:

1-inch and smaller,	2,000	pounds	hydrostatic.
1¼ to 2-inch,	1,500	"	"
2½ to 4-inch,	1,000	"	"
5 and 6-inch,	800	"	"
8-inch,	600	"	"
10 and 12-inch,	500	"	"

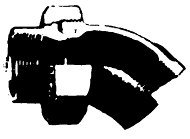
These fittings are tested to hydraulic pressures corresponding to the above working pressures.

Unions and Union Fittings



No. 519.

Made with **leak proof brass to iron seat** require no gaskets, may be taken apart readily and the seat is non-corrosive. Made of malleable iron for steam working pressures up to 250 pounds.



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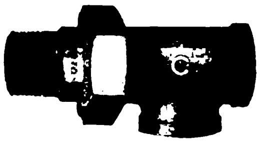
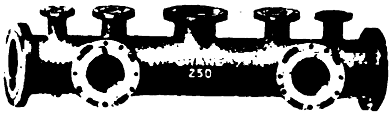


No. 596.

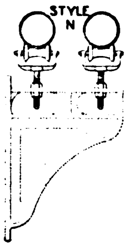
Headers

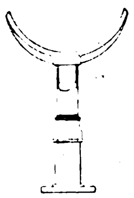


We have exceptional facilities for making any required design of headers in cast iron, ferrosteel or cast steel, for all pressures and purposes.

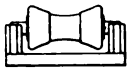
Pipe Supports, Hangers and Brackets

Are suitable for pipe lines up to 30-inch.

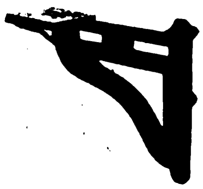




Style H.



Style C.



Our new Catalogue No. 50, which describes our complete line of 17,000 articles, will be mailed upon request.

FOSTER ENGINEERING COMPANY

Manufacturing Engineers of Automatic Valve Specialties

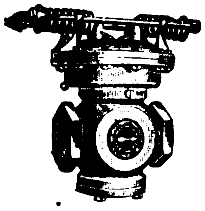
NEWARK, NEW JERSEY

Branch Offices:
CHICAGO PHILADELPHIA BOSTON PITTSBURGH

Products

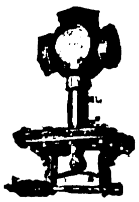
The "Foster" Pressure Regulators; Pump Governors, Non-return Stop Valves; Emergency Stop Valves; Float Valves; Back Pressure Valves; Fan Engine Regulators; Free Exhaust or Atmosphere Relief Valves; Lever Balance Valves; Hydraulic Reducing, Regulating and Relief Valves; Vacuum Regulators, and kindred devices.

Class W Pressure Regulators



Designed to maintain a constant terminal pressure of steam, water, gas or air, under certain conditions, from an available initial or supply pressure in excess of same. Simple in construction, rugged, compact, easily repaired. Ample capacity, no dash pot, noiseless, no small parts to stick. Diaphram actuated with compensating springs externally fitted. Suitable for initial working pressures up to 250 lbs. and for terminal pressures of from 5 to 125 lbs. (dependent on spring power). For service where demand at reduced pressure is fairly constant.

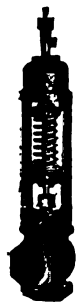
Classes Q. and Q. H. Pressure Regulators



A sensitive, reliable Regulator for heating systems (air or steam). A high-grade low pressure Regulator. No weights or close fitting pistons and is easily adjustable for pressures desired between 0 and 15 lbs. The most reliable steam heating Regulator produced—upkeep reduced to minimum. Made in sizes ¾ inch to 12 inches. Smaller sizes 2 inch and under are fitted with brass bodies; larger sizes have iron bodies, composition mounted and composition renewable seats.

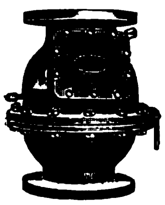
"Q. H."—Same Valve with differential inlet and outlet connections facilitating easy application to enlarged outlet piping connections.

Piston Actuated Pump Governor



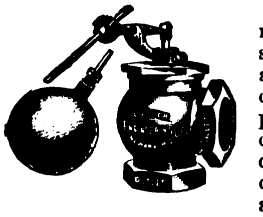
Designed for general service and to meet the demand for a Pump Governor that controls the discharge pressure from the pump. Fitted with renewable composition discs, easily and quickly renewed, insuring tight seats. An extremely simple, self-contained Governor—set the adjusting spring for the desired discharge pressure from pump and the Governor will do the rest. Made in angle and straightway body. Sizes one-half to two inches, inclusive, all composition. Two inches and larger, iron body, composition mounted. Will give closer and longer continuous service than any other similar Valve on the market.

Foster Back Pressure Valve



The Foster Back Pressure Valve aims to reduce common difficulties usually experienced with inefficient competitive products, and was designed to meet the demand of modern practice. Does not chatter. Durability, reliability, functioning power at any pre-determined pressure—0 to 15 lbs.—fully assured. The only thoroughly cushioned self-contained Back Pressure Valve on the market. Made in flanged ends, sizes 2½ inches to 20 inches.

Foster Float Valve



Auxiliary operated (can also furnish "direct acting types"). Quick, sensitive and positively non-leakable; is not cumbersome or frail in construction. Functions with the pressure in supply pipe; may be located at any desirable point, directly or indirectly connected to a small operating Float in the tank. Invaluable on steam line and automatically controlling admission of steam to pump returning water of condensation. May be used in other ways. Angle and globe bodies. Sizes up to two inches, inclusive, all composition. Larger sizes iron body, composition mounted, with removable seats.

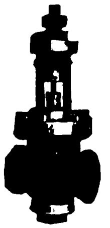
Class G Pressure Regulator

A superior high-grade Pressure Regulator that does not leak or stick. Suitable for final working pressure from 0 to 250 lbs. Single seated, auxiliary operated. Holds tight. Suitable for air, steam, oil or water under certain conditions. (We advise them.) Can be installed equally well on horizontal or vertical pipe. Internal parts are easily and quickly renewed. All auxiliary parts interchangeable. Especially recommended for service where demand for reduced pressure is intermittent.

Class U Pressure Regulator

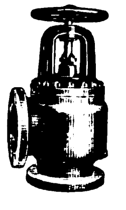
A water pressure regulator that regulates (equally adaptable for air service under certain conditions). Capable of reducing 300 pounds initial pressure to a final of from 5 to 200 pounds. A strong, rugged, reliable product. For service where a steady, even delivery pressure is required whether discharge lines are open or closed. Main valve is fitted with soft disc, easily renewable when necessary. Globe body only. Sizes ½ inch to 2 inches, inclusive, all composition. 2½ inches to 12 inches, iron body, composition mounted.

Class G Pump Governor



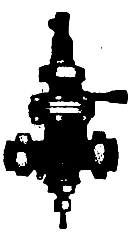
Auxiliary operated, fitted with diaphram on water end, adapted for any service where a steam driven air compressor or Pump Governor can be used and is, without exception, the most satisfactory Valve that has been produced for the regulation and automatic control of pumps. None better. Recommended for hard service where the most severe and exacting duty and close regulation is desired. Guaranteed to operate within a variation of three pounds or less. Holds tight. Made only in globe bodies. Can be installed in any position. Sizes ½ inch to 2 inches, all composition; 2½ inches to 6 inches iron body, composition mounted. For discharge pressure up to 300 lbs.

Automatic Non-Return Stop Valve



Automatically cuts out a defective boiler in the event of blowing out of tubes, poor firing, etc. By their use the admission of steam to a cold boiler from the battery to which it is connected is impossible. A positive factor of safety. The only thoroughly cushioned Non-Return Valve extant. An equalizing Valve. The "Watch Dog" to the boiler equipment. Does not stick, bind, pound or chatter. Fitted with removable seat rings, keyed. For saturated and (especially prepared) superheated steam. Produced in Angle or Globe Bodies. Semi-steel and cast steel. Designed for service rather than to meet competition.

Foster Class G Fan Engine Regulator



Designed to automatically control direct connected fan engine or jet blower system by the boiler pressure. For forced or induced draft equipment. Simple in adjustment. Guaranteed to operate within two pounds variation in pressure. Solely a high-grade device. Sizes one-half inch to two inches, composition, union ends only. Larger sizes iron body, brass mounted, screwed or flanged ends as desired. Strainers furnished. Requires no manual attention after adjustment.

Homestead Valve Manufacturing Company

Works, Homestead, Pa. :: :: :: P. O. Box 1754, Pittsburgh, Pa.

MANUFACTURERS OF

Homestead "Quarter Turn" Valves, "Hovalco" Angle Blow-Off Valves and Other Specialties

---

Products

HOMESTEAD SELF-LOCKING STRAIGHTWAY, THREE-WAY, FOUR-WAY, AND ANGLE HIGH PRESSURE BALANCED PLUG VALVES AND HOMESTEAD LOCKING COCKS. FOR STATIONARY, LOCOMOTIVE AND MARINE USE.

Special High Grade Metal Valve for Resisting Mine Water and Other Acids.

The Homestead Valve is "Unlike all Others," especially unlike Globe and Gate Valves because when pressure passes through it the seat is **absolutely protected from wear.** Fully opened or closed by a quarter turn, straight and unobstructed passage, making it particularly suitable for the handling of heavy liquids or for carrying off sediment.

Dsecription

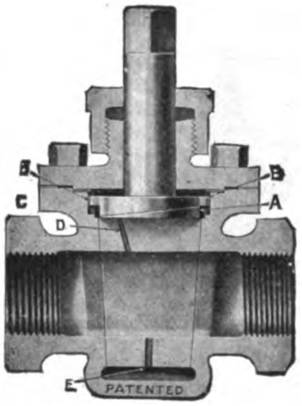


Fig. 1—Sectional View Homestead Straightway Valve.

Fig. 1 is a sectional view. The valve is so constructed that when it is closed the plug is at the same time forced firmly to its seat. The traveling cam "A" is prevented from turning with the stem by means of the lugs "B," which move vertically in slots. When valve is open the cam will be in the lower part of the chamber in which it is placed and the plug will be free to be easily moved. A quarter of a turn causes the cam to rise to the upper surface of the chamber, while a slight motion in the other direction releases the cam and the plug turns easily to its proper open position. "E" and "D" are balancing ports which allow the pressure to predominate at the top of the plug holding it gently in its seat while valve is open. Made in all sizes up to 6 inches and for all pressures up to 5,000 pounds per square inch: in Straightway, Three and Four-way patterns.

Homestead Acid Resisting Valve

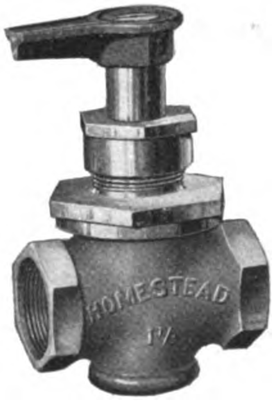


Fig. 4—Homestead Acid Resisting Straightway Valve

The valve shown in Fig. 4 was designed to supply the demand for a valve which would withstand the effects of sulphuric and other acids. It is also used for many other kinds of service. It outwears several valves made of ordinary steam metal. The brass used is a high grade special metal especially suitable for the purpose. It will withstand a higher pressure and more exacting service than the ordinary kind of valve. The mechanical principles are the same as in the Homestead Straightway Valve. Also made of Monel Metal for special service.

The Homestead Valve is best known as a Boiler Blow-off Valve. It is extensively used for this service on stationary, marine and locomotive boilers.

Homestead Three-Way and Four-Way Valves

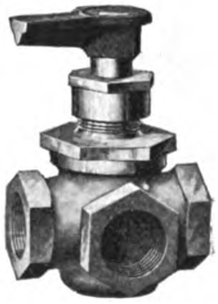
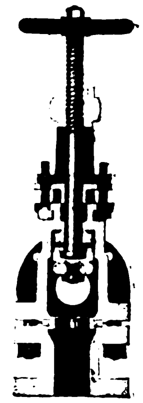
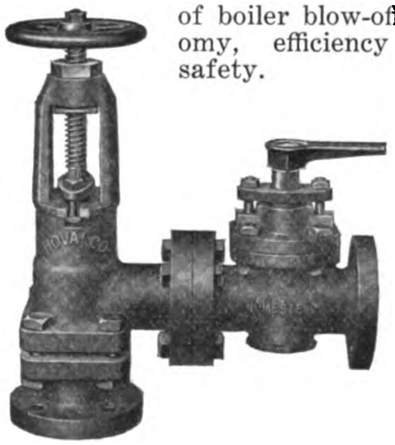


Fig. 9—Homestead Three-way Valve; Brass, 200 Lbs. Working Pressure.

The Homestead Three-Way and Four-Way Valves are used principally in operating hydraulic or pneumatic machinery in factories, mills, mines and on railroads. They are made according to the same principle as the Homestead Straightway Valve and are superior to the ordinary Three-Way and Four-Way Cocks in every way.

The Hovalco Angle Blow-Off Valve is the last word in Angle Boiler Blow-Off design. The **Hovalco** is based upon experience gained through twenty-five years of valve making, and is a result of years of careful investigation and close analysis of all details which enter into the make-up of boiler blow-off economy, efficiency and safety.





The **Hovalco** is shown here bolted to the famous Homestead Quarter Turn Blow-off Valve. The combination is in accordance with the recommendation of the Committee on Uniform Boiler Laws of the A. S. M. E. In some States such a Combination is compulsory by law.

The **Hovalco** Angle Blow-off Valve is guaranteed for a period of two years.

Catalogue

Our catalogue fully meets the requirements of the trade. It will be of great service to you when ordering valves or seeking information regarding their construction. We will be pleased to send you a copy upon request.

JENKINS BROS.

80 White Street
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133 No. 7th Street
PHILADELPHIA

300 West Lake Street
CHICAGO

Jenkins Bros., Limited, Montreal and London. Jenkins Rubber Co., Elizabeth, N. J.

Products

Jenkins Bros. Valves, in Brass, Iron Body, and Cast Steel, for all pressures and purposes; Mechanical Rubber Goods, Sheet Packing, Gaskets, Gasket Tubing, Pump Valves, Valve Discs, Union Rings, and the like.

Valves for Mining Service

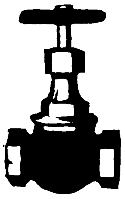


Fig. 106
Brass Globe Valve. Standard Pattern.

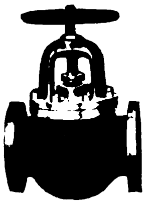


Fig. 142
Iron Body Globe Valve. Standard Pattern.

Jenkins Bros. Standard Pattern Brass Globe, Angle and Cross Valves, sizes ⅛ to 3 inches, screwed or flanged, regularly furnished with Jenkins No. 119 Discs, suitable for 150 pounds steam pressure. When specified for cold water, valves are fitted with Jenkins No. 93 Discs, suitable for working water pressures up to 250 pounds. Other sizes in brass made from iron body patterns.

Jenkins Bros. Standard Pattern Iron Body Valves are heavier and stronger than the average iron body valves. They have renewable seat rings and Jenkins Discs; and are suitable for same working pressures as the standard pattern brass valves. Globe and Angle Valves made in sizes 2 to 24 inches, inclusive; Cross Valves up to 8 inches. Flanges A. S. M. E. standard dimensions.

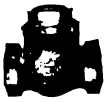


Fig. 352
Brass Swing Check Valve.

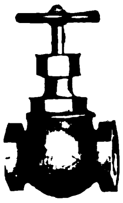


Fig. 75
All Iron Globe Valve.

Jenkins Bros. Brass Horizontal, Angle and Vertical Check Valves correspond to same standard as the Standard Pattern Globe and Angle Valves. Regularly furnished with Jenkins Disc of semi-hard composition which will soften slightly under the action of hot water as required for boiler feed lines. When specified for cold water, air or gas, a softer and more flexible rubber disc is supplied, usually Jenkins No. 93 composition. Suitable for 150 pounds working pressure. Sizes ⅛ to 3 inches, screwed or flanged.

Jenkins Bros. Brass Swing Check Valves, Standard Pattern, are made with globe shaped bodies adapted for either horizontal or vertical installation; have renewable disc feature same as the horizontal pattern; and are spitable for same working pressures. Sizes ¼ to 3 inches, screwed or flanged.

Jenkins Bros. Iron Body Horizontal, Angle, Vertical and Swing Check Valves made in sizes 2 to 10 inches; suitable for working pressures up to 150 pounds.

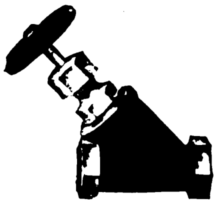


Fig. 125
Brass Y Valves. Standard Pattern.

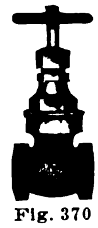


Fig. 370
Brass Gate Valve. Standard Pattern.

Jenkins Bros. All Iron Valves are recommended for service in places where, on account of possible corrosion, no brass mountings of any kind can be employed. The all iron bodies and mountings and renewable discs of cast iron or of special Jenkins composition, make them suitable for handling solutions of cyanide, saltpetre, caustic potash, and the like. It is advisable when ordering to specify conditions of service, so that disc of proper composition will be furnished. All Iron Renewable Disc Globe and Angle Valves, with screwed hub, as Fig. 75, sizes ½ to 2 inches; with yoke, as Fig. 142, sizes 2½ inches and up; horizontal, angle and vertical check valves, ½ inch and up. All Iron Gate Valves with solid iron, double faced wedges, sizes ½ inch and up.

Fig. 331
Iron Body Gate Valve, with Yoke.

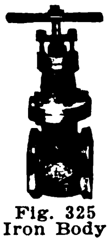


Fig. 325
Iron Body Gate Valve. Inside Screw.

Jenkins Bros. Y Valves, besides their extensive use for blow-off service, are particularly desirable for handling muddy or gritty water. Have renewable seat rings and Jenkins Discs; suitable for 150 pounds working steam pressure, or 250 pounds working water pressure. Brass valves, sizes ⅜ to 3 inches; iron body valves, with yoke 2, 2¼ and 3 inches; with bolted bonnet 3½ to 8 inches, inclusive.

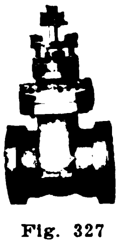


Fig. 327
Iron Body Gate Valve, Hub Ends.

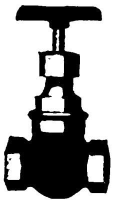


Fig. 128
Brass Globe Valve, Extra Heavy

Jenkins Bros. Gate Valves, all of the solid wedge double face type, are made in three distinct patterns, both inside screw, and outside screw and yoke. Standard Pattern, suitable for 125 pounds steam or 175 pounds water pressure, sizes, brass ¼ to 3 inches, iron body 2 to 30 inches, inclusive. Flanges are A. S. M. E. Standard Dimensions. Medium Pressure, specially designed for steam or hot and cold water lines where high grade installation is required; but where the pressure does not warrant the use of the more expensive extra heavy pattern, are guaranteed for 175 pounds steam and 250 pounds water. Sizes: brass, ¼ to 3 inches; iron body 2 to 18 inches, inclusive, with or without by-pass. Flanges A. S. M. E. Extra Heavy Standard Dimensions. For high pressure steam and hydraulic pressures, valves are made for extra heavy patterns in brass, iron body, and cast steel.

The Extra Heavy Pattern Brass Globe, Angle, Cross and Check Valves are suitable for working steam pressures up to and including 300 pounds; or for water and air pressures up to 500 pounds. Sizes ¼ to 3 inches.

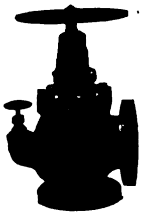


Fig. 164-c
Iron Body Angle Valve, Extra Heavy with By-Pass.

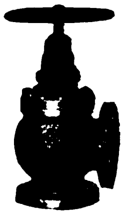


Fig. 293
Automatic Equalizing Stop and Check Valve.

Extra Heavy Iron Body Valves are suitable for working pressures up to 250 pounds steam and 400 pounds water. Globe, Angle and Cross Valves made in sizes 2 to 12 inches; valves from 5 inches up can be supplied with by-passes which are cast integral with the body. Horizontal and Vertical Check Valves 2 to 6 inches; Swing Check Valves, 2 to 8 inches; Y Valves, 2 to 3 inches. Automatic Equalizing Stop and Check Valves designed to equalize the pressure in a battery of boilers, preventing one boiler from working at a lower pressure than another, insure against accidents as they automatically shut off the flow of steam from header to boiler in event of a broken tube or connection. Sizes 4 to 8 inches. Gate Valves, with inside screw, or outside screw and yoke, sizes 1½ to 24 inches; all flanges A. S. M. E. Extra Heavy Dimensions.

Jenkins Bros. Cast Steel Valves are made in Globe, Angle, Gate and Check patterns, which experience has shown are perfectly adapted for the severe conditions incident to high pressure super-heated steam service. The valves are suitable for working steam pressures up to 350 pounds, and total temperature of 800 degrees F. Furnished in practically the same sizes as the Extra Heavy Iron Body Valves.

Mechanical Rubber Goods.

In this line we are offering engineering requisites which are the result of over 50 years of progressive effort. We are the original manufacturers of rubber composition discs for valves and unvulcanized sheet packing.

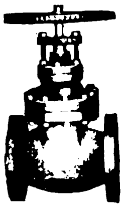


Fig. 203
Iron Body Gate Valve. Extra Heavy Inside Screw

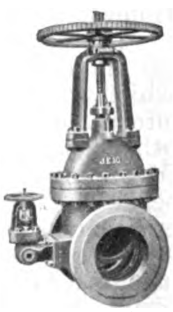


Fig. 204-b
Iron Body Valve, Extra Heavy O. S. & Y.

Jenkins '96 is the name of our high grade unvulcanized or self-vulcanizing packing, furnished in sheets or gaskets, and unsurpassed for all kinds of saturated steam joints. Jenarco is a vulcanized red sheeting. It is very tough and pliable, equally suitable for steam, hot or cold water, and other joints.

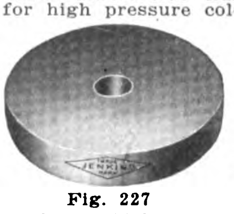


Fig. 227
Pump Valve.

Jenkins Bros. Pump Valves are made from various compounds. There are pump valves of hard composition, particularly adapted for hot water, as with boiler feed pumps; for oils, acids, and other destructive fluids; semi-hard valves for high pressure cold water service as in mines; medium soft for cold water; very soft and flexible for low pressure cold water and air. When ordering, state the kind of service in which the valves are to be used, the fluid handled, pressure or head pump is working against, and in all cases give diameter, thickness and size of hole.

When ordering be particular to specify the full name—Jenkins Bros.—and do not accept unless goods bear our registered trade mark as shown in the cuts. All Jenkins Bros. products are absolutely guaranteed to be perfect in workmanship, and suitable and efficient in the service for which they are designed.

W. H. NICHOLSON & COMPANY

WILKESBARRE, PA.
Representation in Most Cities.

Wyoming Automatic Eliminators,
Wyoming Steam Traps
Wyoming Separators

Products

Wyoming Automatic Eliminators (combined steam separators and traps); Wyoming Steam Separators; Wyoming Steam Traps (weight or piston operated).

Nicholson Expanding Lathe Mandrels; Nicholson Locomotive Eccentric Expanding Mandrels; Nicholson Compression Shaft Coupling; Nicholson Boiler Tube Expander.

General Machine Jobbing and Contract Work.

Wyoming Automatic Eliminator

For the last eleven years this **combined separator and trap** has been one of the most widely used devices for safeguarding steam engines and pumps in the anthracite and other American coal mining regions.

The long steam lines so frequent in the mining regions naturally produce tremendous volumes of condensate, which must be eliminated to assure dry steam in prime mover cylinders. In addition to condensate, the slugs of water which often traverse these lines make steam drying very difficult—practically impossible, in fact—for any apparatus not especially designed for the service.

Wyoming Automatic Eliminators of either type are unqualifiedly guaranteed to keep steam lines 99.5% dry.

Vertical Type

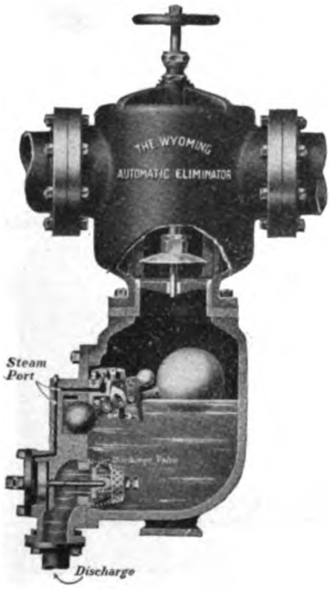
The verticle type, shown in the next column, is used successfully between throttle valve and the steam chest. It can be placed as close to the steam chest as desired, and assures dry steam in the cylinder.

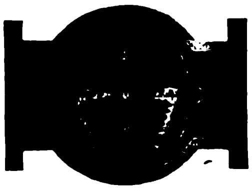
It is used for outside service extensively, but not to the same degree as the

Horizontal Type

The two cross sections below show clearly the differences of these two types. Both are guaranteed to remove the same amount of water or moisture from steam—99.5%.

The trap-section is unique in that it has greater **discharge capacity** than traps of any other make, rated at the same **trap** capacity. In one size, alone, for example, the discharge area in the traps of these eliminators is **sixteen** times that of other devices.





In this—the horizontal type—six vertically corrugated baffles assure complete separation. The trap below drains instantly without wiredrawing.

Wyoming Separator

Practically the same as the separator section of the eliminator. It is designed for the same purpose, and differs only in the substitution of a drain tank for the steam trap. It can be used in combination with a trap, if desired.

Like the eliminators, it is also guaranteed to arrest 99.5% of the moisture in steam lines.

It is drained manually, instead of automatically, and fitted with a water glass for measuring the level in the tank.

Wyoming Steam Trap

It is made in two general types—weight-operated or piston operated. In both designs wiredrawing through the discharge valve is impossible, since movement is so fast that the seat is closed or opened instantly. In the weight-operated type the weight controls opening, and the float controls closing. The piston type is steam controlled. When the float reaches its highest point it opens a needle valve which admits steam to the piston. The valve opens instantly. When the water level recedes enough the falling float shuts off the steam supply and the pressure drives the valve back at once.

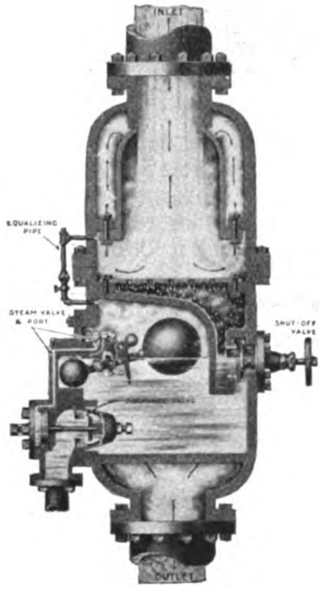
Other Products

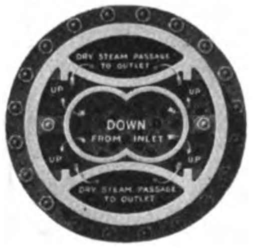
The popularity of the other Nicholson and Wyoming products listed in the first paragraph is attested by their extensive use.

Descriptive matter covering all products will be sent immediately on request.

We will be glad to ship any of our devices to users for a thorough 30-day test.

The engineering department is always anxious to consult with possible users of any of these products. If you are trying to find a better way of doing things on a lathe, milling machine or grinder, in power or steam transmission, let our engineers assist you.





In the vertical type a perforated baffle plate catches all water. The trap section below is piston or weight-operated. These devices are **separator-traps**.

NORTHERN EQUIPMENT COMPANY

Main Office and Works: ERIE, PA.

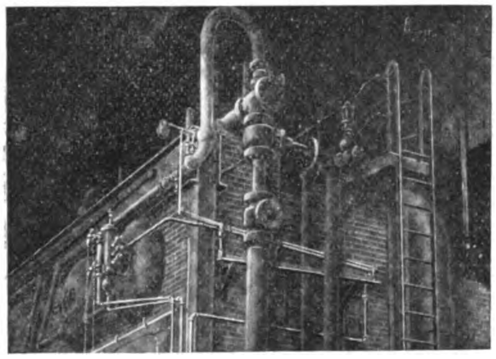
Copes Boiler Feed Regulators—Copes Pump Governors

Copes Boiler Feed Regulators

The Copes Boiler Feed Regulator operates in accordance with the modern idea that the water should be fed continuously while the boiler is under load, and that the water level should be automatically lowered to increase the steaming capacity to carry peak and overloads; that during subnormal and no loads the level should be raised to store up heat energy which would otherwise be wasted through the pop valve or up the stack.

"This method of feed control enables peak loads of short duration to be carried with a more uniform working of the furnace, as sudden demands for steam will cause a fall in the water level without a corresponding increase in the rate of feed."—B. F. Wood, Report of Committee on Power Generation, Am. El. Ry. Eng. Assn.

Copes Regulators have no Floats, Springs, Diaphragms, Pilot Valves, Concealed Parts or delicate mechanism. They can be installed on any boiler and are guaranteed as to operation and maintenance.. Control valve can be placed in horizontal, vertical or angle feed line and either above or below the expansion tube. Operation is absolutely reliable and is dependent upon direct expansion and contraction of a straight metal tube six feet long.



Typical Installation on B. & W. Boiler.

Automatic boiler feeding is no longer a luxury but a vital necessity of the modern boiler plant.

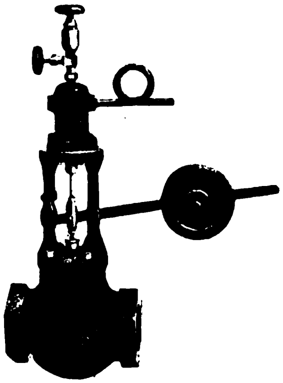
The Copes Regulator means this to you:

1. Higher overload capacity.
2. More constant furnace conditions.
3. Less drop in pressure at overloads.
4. Storage of heat at low loads.
5. Even distribution of load between boilers.
6. Smooth rate of feed; no spasmodic opening and closing of the feed valve.
7. Smaller feed lines and valves.
8. More even load on feed pump.
9. More legible water meter and steam meter charts.
10. Dry steam since the water level cannot exceed a predetermined level and because the level is a minimum for greatest loads.
11. Higher superheat because water is not carried over into superheater tubes.
12. More constant superheat because the rate of steam delivery is not affected by intermitten feeding.
13. Higher temperature of feed water, which is drawn from the heater at a more even rate.

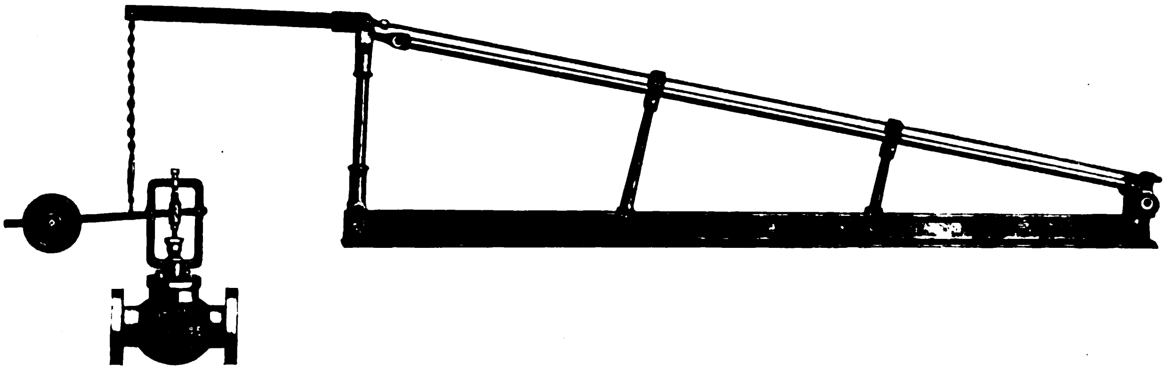
Copes Pump Governors

The Copes Pump Governor comprises a balanced valve controlling the steam supply to the pump or turbine driving the pump, a small cylinder and operating piston, a lever, and counter-weight. Made in Flanged, Angle or Straightway type; sizes 1¼″ to 8″ and Screwed Angle or Straightway type; sizes ¾″ to 3″.

When used for boiler feed service, the governor is installed to maintain a constant difference between feed line and boiler presures. Also widely used for maintaining constant pump pressure, as for house tank service, fire pumps, elevator pumps, etc.



Copes Pump Governor.



Copes Boiler Feed Regulator.

HUNTER PRESSED STEEL CO.

Office and Works
Orthodox and Horrocks Sts., Philadelphia, U. S. A.
Manufacturers of

Trade **Airspring** Mark

Compressed Air Grease Cups

Automatic - Saves 50 Per Cent. - Simple

What It Is

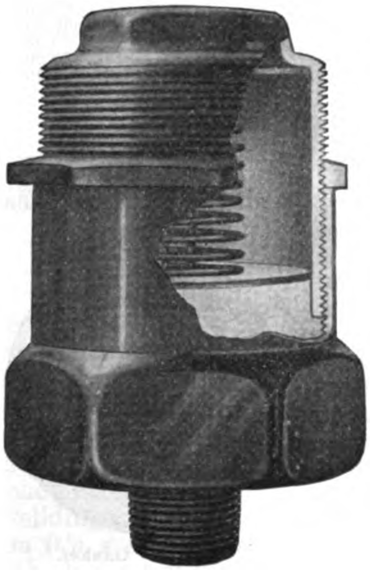
"AIRSPRING" Compressed Air Grease Cups are the newest and most practical automatic grease cups designed and embody features not to be found in any other type of grease cup. They are particularly ideal for use on all kinds of MINE MACHINERY and many of the leading Coal Companies are enthusiastic users of "AIRSPRING" cups.

How It Works

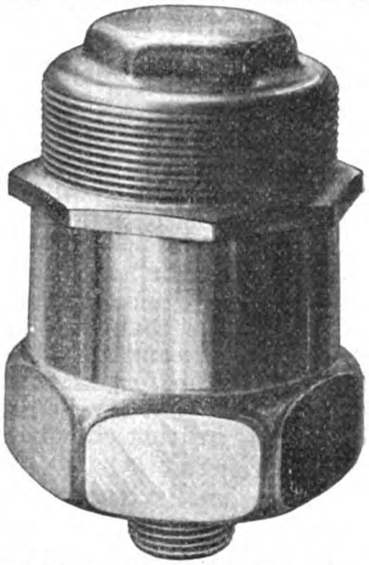
"AIRSPRING" Compressed Air Grease Cups feed the grease automatically by the use of compressed air. No external means of any kind are required to provide the compressed air, as the compression is provided automatically by the act of screwing down the top of the grease cup itself. The light spring is adapted to provide capacity for leveling the grease when adjusting the top to the grease filled body and, at the same time, insures greater flexibility and positiveness of operation by supplementing the air pressure, especially at periods just prior to readjustment. The internal disc and spring parts are REVERSIBLE and cannot be put in wrong and are readily removable, hence the top portion of the cup is easily cleaned. There are no parts to wear, nothing to get out of order or become bound; nothing to shake loose and interfere with the positiveness of the air pressure.

What It Does

"AIRSPRING" Compressed Air Grease Cups automatically establish and maintain a film of grease on the bearing. Only as the bearing needs more grease, will it be supplied; it is by the combined action of the journal bearing, when in motion, drawing the grease and of the compressed air providing a constant live pressure upon the grease, that proper lubrication is secured with the greatest efficiency and the utmost economy.



"AIRSPRING" Compressed Air Grease Cups effect no change in the consistency or lubricating qualities of the grease; the last portion being the same, in these particulars, as the first. The capacity of the cup is such that it may be adjusted to give any required pressure to suit any duty and grease of almost any consistency, while at no time permitting an abnormal pressure upon the grease, such as occurs in grease cups relying wholly upon spring or mechanical pressure. The rate of feed is conveniently controlled by turning the top of the cup by hand and the compressed air, thus regulated insures sufficient pressure for positive, automatic feeding without detriment to the consistency of the grease.



How It Saves

"AIRSPRING" Compressed Air Grease Cups save a ⅓ to a ½ of the grease, men's time and energy. Cups only require adjustment once a month for line shafting or slow speed machinery, and once or twice a week for high speed machinery.

Its Good Points

"AIRSPRING" Compressed Air Grease Cups are automatic, simple, strong, light, reliable, dirt-proof, elegant, economical. Cup feeds in any position.

Feeds against centrifugal force. Feeds just enough—and no more—grease to keep the bearing cool and easy running, insuring economy as well as a clean bearing, uniformly and perfectly lubricated.

In the Making

"AIRSPRING" Compressed Air Grease Cups are cold drawn from the best quality STEEL, and are made in four sizes and four finishes. The cup is light and strong, and when connected, the bottom of the cup forms a large bearing surface, which takes the strain off the shank, insuring great strength and rigidity.

No tools are required to adjust these cups as the threaded top acts to the grip of the fingers the same as a knurled or corrugated part, hence it is a simple matter to screw down the top of the cup by hand.

SPECIFICATIONS

Shanks, pipe thread.....	⅛" or ¼"	¼" or ⅜"	⅜" or ½"	½" or ¾"
Diameter across base....	1¼"	1¾"	2¼"	2¾"
Height over all, Cup Open	2⅞"	3½"	4¾"	5½"

PRICE LIST

Capacity	½-oz.	1-oz.	3-oz.	6-oz.
Plain, each..............................	$1.00	$1.25	$1.50	$1.75
Polished, each	1.20	1.60	2.00	2.50
Brass or Copper Plated...........	1.60	2.00	2.50	3.00

Subject to discount.

Your dealer sells "AIRSPRING" Cups, if not, order direct.

Free Trial

We will send you one or more "AIRSPRING" Cups for a 60 days' free trial. If, at the end of that time you are not satisfied, send them back. The cups must make good or no pay. WRITE FOR A TRIAL CUP, DESCRIPTIVE FOLDER and DISCOUNTS.

McCORD MANUFACTURING CO.

DETROIT, MICH.

Branch Offices
NEW YORK, N. Y. CHICAGO, ILL.

Manufacturers of

Forced Feed Lubricators and "McKim" Gaskets

Products

Forced Feed Lubricators and "McKim" Copper-Asbestos Gaskets.

McCord Force Feed Lubricators

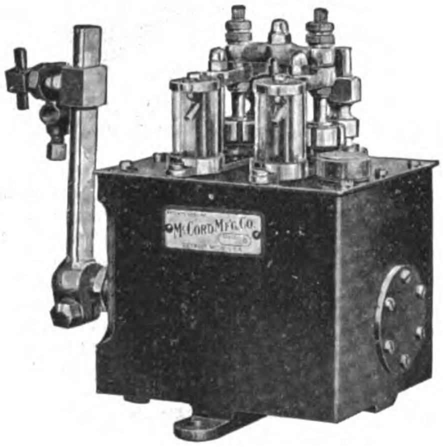
The McCord force feed lubricator is made in from 1 to 14 feeds, and has a separate pump for each feed. Each pump has individual adjustment. It has constant sight feeds, which show exactly how much oil is being pumped to each bearing, and the flow can be adjusted from one drop to a full stream per stroke.

It is positive and automatic in action and operates in perfect synchronism with the engine or pump it is lubricating. It is not affected by viscosity of oil, variations in steam pressure or length of feed line.

Advantages

In addition to its standard features, such as positive sight feeds without pressure, separate pumps capable of individual adjustment for each feed, forced delivery of oil against pressure up to 1,000 lbs., etc., it has special advantages not found in any other device, as follows:

Iternal mechanism—all working parts immersed in oil; auxiliary hand crank for accelerating feed; drop forged operating lever; reversible end bearing, that can be driven from right or left hand end; heating chamber plug for draining reservoir. (See Catalog for details.)



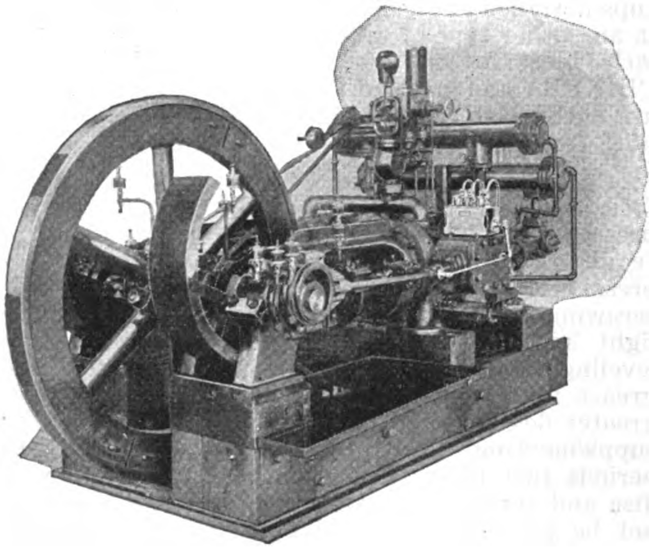
McCord Force Feed Lubricator.
Class B, 2 Feed

CAPACITIES AND PRICES

Capacity	Feeds	List	Capacity	Feeds	List
1 Quart	1 Feed	$25.00	1 Gallon	5 Feed	$ 57.00
1 Quart	2 Feed	30.00	1 Gallon	6 Feed	63.00
2 Quart	1 Feed	28.00	1½ Gallons	7 Feed	75.00
2 Quart	2 Feed	35.00	1½ Gallons	8 Feed	82.00
2 Quart	3 Feed	42.00	1½ Gallons	9 Feed	90.00
2 Quart	4 Feed	49.00	1½ Gallons	10 Feed	96.00
1 Gallon	1 Feed	33.00	2 Gallons	11 Feed	108.00
1 Gallon	2 Feed	39.00	2 Gallons	12 Feed	115.00
1 Gallon	3 Feed	45.00	2 Gallons	13 Feed	125.00
1 Gallon	4 Feed	51.00	2 Gallons	14 Feed	135.00

Write for Discount.

There is positively no pressure in sight feed; all working parts are of the best drop forged steel and operate in oil. Rotary or ratchet drive, finished in full nickel plate or black enamel and brass. Straightaway spring check valves. Heating chamber and auxiliary hand crank furnished, as extras, when specified.



Three Feeds—Two Compartments
Lubricating a Laidlaw Dunn Gordon Company Steam Driven Air Compressor in the Power Plant of the Detroit United Railway, at Farmington, Michigan. Feeding one grade of oil to steam cylinder and another to air cylinder.

CAPACITIES AND PRICES

2 Quart	2 Feed	1 Feed in each	$44.00
2 Quart	3 Feed	2 and 1 Feed in each	50.00
2 Quart	4 Feed	2 Feed in each	57.00
1 Gallon	2 Feed	1 Feed in each	47.00
1 Gallon	3 Feed	2 and 1 Feed in each	54.00
1 Gallon	4 Feed	2 Feed in each	60.00
1 Gallon	4 Feed	3 and 1 Feed in each	65.00
1 Gallon	5 Feed	3 and 2 Feed in each	70.00
1 Gallon	5 Feed	4 and 1 Feed in each	70.00
1 Gallon	6 Feed	4 and 2 Feed in each	75.00

Write for Discount.

"McKim" Copper Asbestos Gaskets

A pliable copper casing surrounding an asbestos packing, designed and constructed to withstand the ravages of heat, pressure and chemical action. Guaranteed not to spread or blow out and to withstand any pressure or superheat. May be re-applied repeatedly. "McKims" are saving from 50% to 80% of **gasket maintenance** in thousands of plants. Write today for free samples.

"McKim" Gasket.

CANCOS MANUFACTURING CO.

Garden and Bridge Sts. PHILADELPHIA, PA.

Manufacturers of

PREPAREDNESS

Products

We manufacture a complete line of Packing; Pump Valves; Hydraulic Rings; Asbestos and Rubber Gaskets; Metal Polish; Water and Steam Hose, Etc.

The most efficient packing in use today in the coal mining districts.

Why?

Long service which does not necessitate frequent shut-downs.

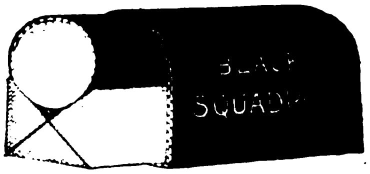
Thorough Lubrication which means repair bills reduced to a minimum.

Nominal cost, thereby reducing your yearly upkeep for packing.

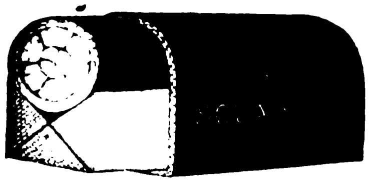
Backed by 25 years of packing manufacturing experience.

The accompaning cuts will give you an idea of the construction of our packing.

Made for every purpose, air, gas, chemicals, ammonia and steam.



High Pressure Up to 150 Lbs.



Low Pressure Up to 100 Lbs.

Observe the sliding wedge principle, embodying the universal chuck idea.

In your own mine prove that it is the best packing you have ever had.

White Squadron

Suitable for slush pumps. Guaranteed to give perfect satisfaction until absolutely worn out in the stuffing box.

White Squadron.

Samples sent upon request. Send for our illustrated catalog.

The Packing That Works on a Principle

It has long been recognized by steam users and manufacturers alike that the sliding wedge form of packing is vastly superior in every way to the old style solid packing, and for this reason every new packing that has appeared recently embodies the "sliding wedge" in one form or another. "Anything so it's a sliding wedge" seems to be the basis on which most of them are made. Here is where Black Squadron Packing differs from all the others. It is not a new packing, by the way; it is one of the old standards in which the sliding wedge principle originated. Nor is the combination of sliding wedges here shown the result of a happy thought, for it took many months of testing and experimenting to get the correct combination that would embody all the best theoretical principles in the practical working combination.

But we got it, and are ready to prove it to the largest users of packing that "Black Squadron" is the longest wearing, best lubricating, air or ammonia packing on the market.

Regarding the Principle

Do you know anything about chucks? If you do, you do not need to have it pointed out to you that Black Squadron embodies the principle of the universal chuck perfectly. If you do not, it will pay you to look into it, then you will better understand why Black Squadron works where other packings fail.

About Materials

It is not necessary for us to go into all the details of why packings charr, burn and blow out, or why they vulcanize and score the rods. Besides, the reasons are not always the same, so all we wish to say on the subject is that Black Squadron packing keeps its pliability all the time, that it wears the same all through.

And the Reason

Is that each grade is made of material especially adapted to the work it is going to perform. Each of the three wedges in Black Squadron is composed of cotton duck and rubber. These are thoroughly saturated and covered with a special lubricating compound. These wedges are capped with a cushion that absorbs all oil and keeps the rod lubricated, causing it to slide backward and forward with the least possible friction, thus prolonging the life of the packing indefinitely. All are encased in a network to keep them in place. This network is made of a specially tough material, because it receives the brunt of the wear on account of its being next to the rod.

Black Squadron Packing

Is made in quite a variety of styles that it may be adapted to all pressures, and every purpose. Furthermore, it is the invention of an engineer of long experience, a man who had helped his "dad" pack the engine on Sundays and holidays, and who understood the needs of his brother engineer to begin with.

DURABLA MANUFACTURING CO.

General Offices:
114-118 Liberty St., N. Y. C.
Branch Offices:
HARTJE OFFICE BLDG., PITTSBURGH 27 NO. 7TH ST., PHILADELPHIA FISHER BLDG., CHICAGO

Asbestos Sheet Packing, Gauge Glasses, Valve Discs, Etc.

DURABLA Asbestos Sheet

The DURABLA Sheet, made from Asbestos Rock Fibre and the best Rubber Bond, is sold on Service Basis and guaranteed to make Tight Joints on All Pipe Flanges and All Flanges on Pumps or Machinery.

The DURABLA Sheet is a Quality Sheet and will not harden or crack in stock or service.

It is equally efficient on high and low pressures, water, oil and gasoline engines.

Sheets measure 48″ x 60″ and 36″ x 120″.

Look for the Durabla Trade Mark on every gasket and sheet. It is the guarantee of the genuine Durabla.

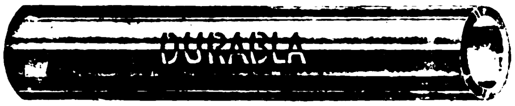
The DURABLA gaskets, cut from the DURABLA Sheet, are carried in stock in all Sizes, all Shapes and Thicknesses.

All orders are promptly filled.

Durabla Metallic Gauge Glasses

The DURABLA metallic gauge glasses have no equal for efficiency and safety. The DURABLA glasses are used and recommended by railroad companies and power houses where these qualities are demanded.

All sizes have fused ends.



"Durabla" Etched on Every Glass.

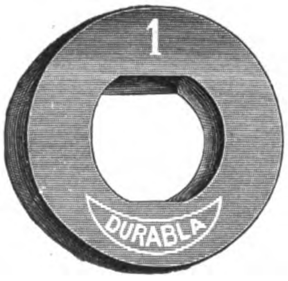
Durabla Lubricator Glasses

The DURABLA Lubricator Glasses are made from the same quality of glass as the gauge glasses and have no equal, being practically unbreakable.

Glasses for klinger gauges always in stock as well as bulls eye glasses for all makes of lubricators.

Durabla Valve Discs

The DURABLA Valve Discs are of exceptional quality. They will stand high temperatures and will not harden or crack. The DURABLA Valve Discs will save extra labor and expense and add life to your valves.



"Durabla" Stamped on Every Disc.

THE GARLOCK PACKING COMPANY

PALMYRA, N. Y.

Branches

New York Boston St. Louis Philadelphia
Chicago Denver Pittsburgh San Francisco
Cleveland Birmingham

We are Exclusive Packing Manufacturers---
We Make Nothing Else

Trade Mark

Products

- Packing—Ring, Spiral, Coil, Sheet.
- Gaskets
- Pump Valves
- Valve Discs
- Gauge Glass Rings
- Moulded Rubber Packings
- Metal Packings
- Bushing Rings.

Have you ever considered the loss in engine efficiency due to excessive friction on piston and valve rods caused by the use of inferior and poorly lubricated packing?

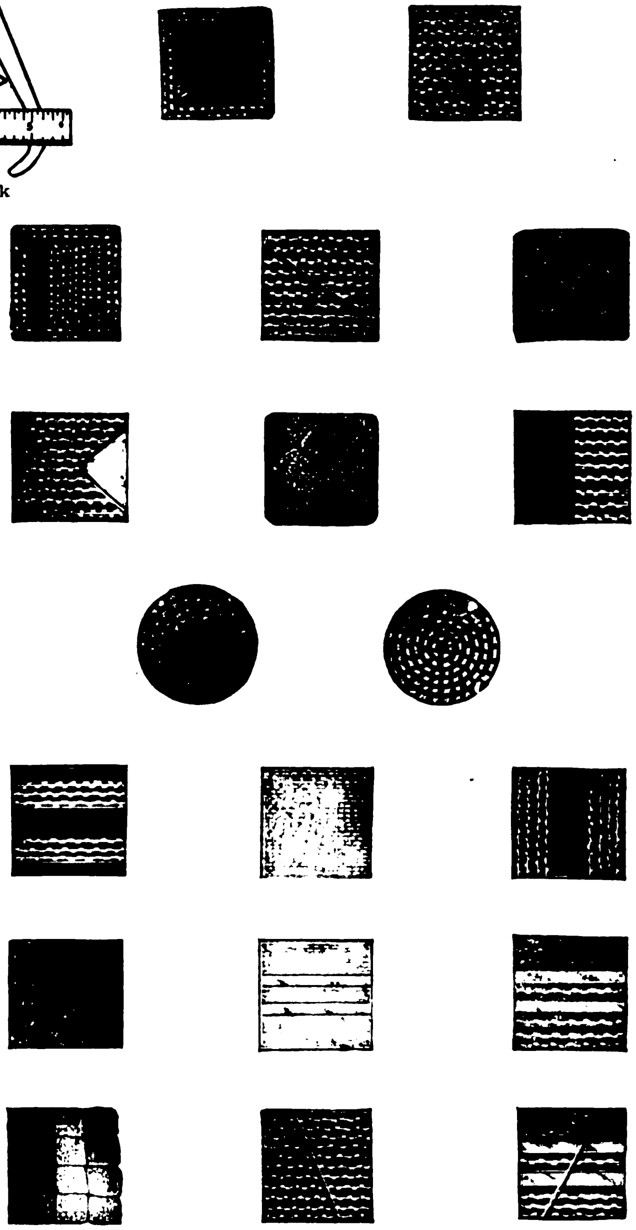
A horse power easily can be absorbed at the stuffing box and, when considered in dollars and cents, the loss would pay for a high-class packing many times over.

In the manufacture of our packings we have steadily insisted upon the best of everything in material, design and workmanship.

All of our efforts have been directed towards improving and perfecting our packings to meet the continual increase in steam and hydraulic pressures, due to the wonderful improvement in modern machinery.

Our factories, devoted exclusively to the manufacture of our packings, are the largest, most modern and best equipped in the world, and the locations of our numerous branch factories and stores are such as to afford the greatest advantage in serving our customers promptly.

We manufacture a line of packings especially adapted to service in coal mines and by-product plants.



The above Cross Sections show construction of some of our packings.

THE B. F. GOODRICH COMPANY

Factories: Akron, Ohio

Representatives in All Districts.

Packing, Valves, Gaskets, Water Hose, Steam Hose, Air Hose, Couplings, Transmission Belting

---

Packing

"SUPERHEAT"—None better for extreme pressure and superheated steam lines. Tested to 1200 degrees and 900 pounds steam pressure. Tensile strength of over 3000 pounds. No ply separation—joints break clean. Smooth surface makes absolutely tight joint. Withstands superheated steam, refrigerating solutions, ammonia, acid, air or gas. Makes joints permanently tight. Will not squeeze or blow out. Vibration does not affect it. Thinner sheet gives more joints per pound. In any practical thickness, plain or graphite on one or both sides.

RED SHEET—A good dependable packing. Made plain or with brass wire insertion. Get a sample of "AKRON" Brand.

Square Duck—Highest quality—fine or coarse duck.

Spiral Duck—Round or square—high or low pressure.

Valves

Goodrich Rubber Valves for hot water, cold water, air pumps, etc., are giving entire satisfaction in mining service. They are built for service. Listed below are seven Standard Goodrich Grades:

No. 25—Soft valve, for cold water, pressures up to 100 lbs.
No. 20—Slightly stiffer than Grade No. 25, suitable for cold water pressures up to 150 lbs.
No. 85—Semi-hard, for cold water pressures up to 200 lbs.
No. 60—Semi-hard, for cold water pressures up to 350 lbs.
No. 200—Standard hard valve, for all classes of hot water service.
No. 305—Soft valve for the best quality, strong, tough rubber for air pumps and jet condenser service and low pressure curved guard work.
No. 120—Standard valve for curved guard service.

Gaskets

We have a rubber gasket of whatever shape and for whatever purpose desired.

Diaphragms

Pump Diaphragms, well constructed from good materials, come in eight sizes, The severe service in these pumps makes the purchase of the best diaphragms obtainable—an economical investment always.

Water Hose

Goodrich Water Hose is long lasting, despite the hardest usage. For dependable service we recommend "Commander," extra heavy cover; "Akron," smooth cover; and "Monitor," smooth cover.

Steam Hose

"Superheat"—a distinctively special hose for extreme service at very high pressures and high temperatures. The quality of the tube and the friction between the plies are the best. "Superheat" is the unusual in steam hose, built for unusual service.

"Goodrich"—has tube of proper thickness and quality to resist heat, oil and pressure and yet retains its "life" to render maximum service. For high pressure work.

"Falcon" — a very substantial hose for light requirements.

Air Hose

Air hose of Goodrich manufacture is designed to cope with rough usage. External abuse from abrasion and falling rocks, unusual wear set up by pulsation, the jarring of blasts, the soaking of hot oil, high intermittent pressures, and other common afflictions of mining practice are guarded against in the most effective, successful manner possible.

Air Hose in Mining Service.

Braided Type

"COMMANDER"—for roughest service. Has extreme flexibility and special oil resisting tube. Cover several times thicker than the average hose. No wire winding or other armor necessary. Recovers immediately from force of blows. No rusting, breaking or distortion.

"Mainstay"—For high pressure lines, as in metal mines and for general usage. Extreme quality. Cover not as heavy as on "Commander."

"Maxecon"—Good grade, substantial and thoroughly reliable.

Wrapped Duck Type

"Quarry"—Strong, sturdy construction, with ply of canvas over outer rubber cover. Protective coverings if desired.

"Falcon"—A cheaper priced hose which will withstand pressure, but not as long as "Quarry."

Couplings

Water, Steam and Air Hose Couplings. Extra shank for high pressure hose.

Transmission Belting

"Commander"—Maximum gripping power—great tensile strength—extreme flexibility—moisture-proof—absorbs shock and strains—runs absolutely true—friction surface, gum cushion type.

"Pinnacle"—Friction surface type, high grade friction. Unusual tensile strength.

NEW YORK BELTING & PACKING CO.

New York, N. Y........91-93 Chambers St.
Pittsburgh, Pa............420 First Ave.
San Francisco, Cal.........519 Mission St.
St. Louis, Mo.........218-220 Chestnut St.
Philadelphia, Pa..........821-823 Arch St.
Chicago, Ill............124-126 W. Lake St.
Spokane, Wash.........157 So. Monroe St.
Boston, Mass.................65 Pearl St.

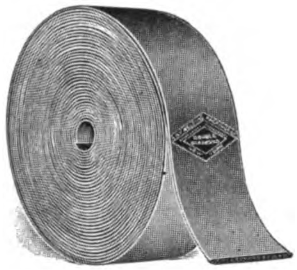
Factories: Passaic, N. J.

AGENCIES IN ALL PRINCIPAL CITIES

Manufacturers of

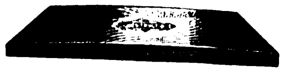
Mechanical Rubber Goods

Transmission Belting



Made in various grades to meet the different conditions of service. With over 70 years experience in belt making and thorough investigation in the field we are in a position to give you the most satisfactory belt for the service for which it is required. Our DOUBLE DIAMOND brand is specially recommended.

Conveyor Belting

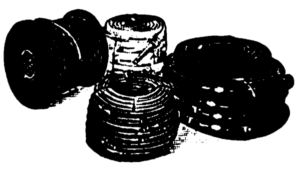


Our "INDESTRUCTIBLE" brand is characteristic of its name. A perfect belt, made of extra heavy selected and specially woven cotton duck, the rubber friction, which binds the plies together of the highest quality. The reinforced rubber cover, 1-16" to ¼" thick is specially compounded to meet the service conditions under which the belt is used and guaranteed to prove ECONOMICAL AND EFFICIENT in conveying all abrasive materials such as cement, ashes, coal, rock, coke, sand, gravel, ore, etc.

Steam Hose

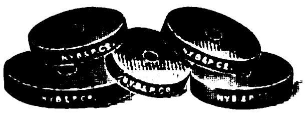
Indestructible Steam Hose is made with a woven jacket between the outer ply of cotton duck, and the rubber cover. Reducing to a minimum, the expansion of the hose under pressure, and preserving at its maximum strength the adhesion of the rubber friction uniting the plies, thus greatly prolonging the life of the hose.

Hose



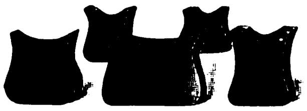
For Coke, Air, Hot or Cold Water, Steam, Gas, Suction, Fire Protection, and all other purposes for which rubber hose is used. Each the best for its intended purpose, and guaranteed to give adequate service commensurate with its cost.

Pump Valves



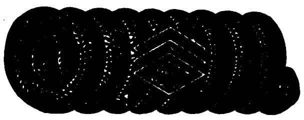
The manufacture of rubber pump valves that will wear is a distinct science in rubber mixing. This is especially so in valves for high lift mine pumps, oils, fire engines, waterworks and high-speed pumps. We have valves for every kind of service, and with a full knowledge of all the conditions we guarantee satisfactory results.

Sheave Filling or Wire Rope Transmission Packing



We have a very large assortment of moulds and are able to supply proper filling for almost any pulley without mould expense. The stock is tough and durable, especially compounded to resist the friction of the wire rope.

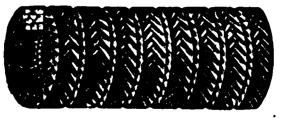
Cobbs High Pressure Packing



still continues to hold the record for service on high pressure steam and air compressors in coal mines. Where Cobbs packing is used you hear of no scored rods or "shutdowns"; that's why it is called the ideal packing. The high grade rubber cushion gives it the necessary spring, the duck cover protects the cushion, over which it has a fine asbestos cover, to resist intense heat.

If you have not used it, give it a trial and prove it to your own satisfaction. Sample sent on request.

Waterproof Hydraulic, Style 114,



we recommend for your deep mine pumps. It has proven to be the most serviceable where pumping sulphurous water containing grit and particles of coal. It is guaranteed to stand a pressure of 3,000 pounds. This is not a new packing, but is the only one that has given real success. Sample sent on application.

PEERLESS RUBBER MFG. CO.

General Offices, 31 Warren St.
NEW YORK

FACTORIES, NEW DURHAM, N. J.

Branch Stores

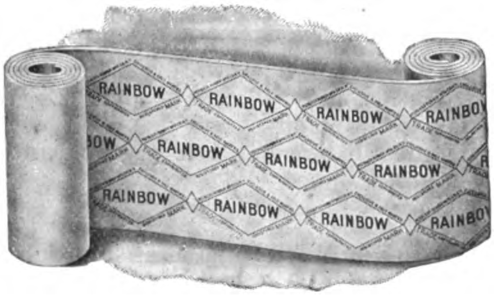
36 Oliver St.
Boston, Mass.

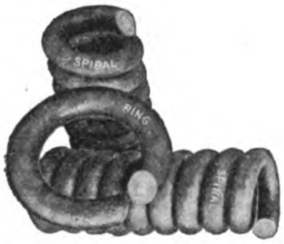
130 W. Lake St.
Chicago, Ill.

122 No. 13th St.
Philadelphia, Pa.

424 First Ave., N.
Minneapolis, Minn.

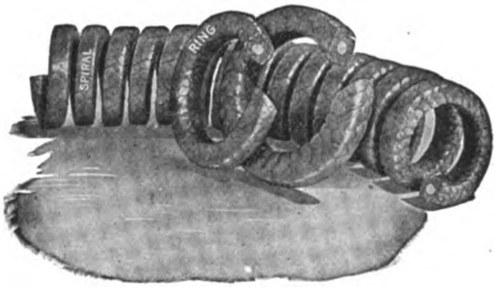
Insist on genuine RAINBOW PACKING. It is the original—never "blows out" or hardens. For steam, air, hot and cold water. Put it in all the flanges—it is your insurance against leaks.





PEERLESS PISTON PACKING is a good universal packing for steam up to 150 lbs., and water. It has a Rainbow core that gives it plenty of resiliency. Made in coil, spiral or ring form.

"HONEST JOHN" is a hydraulic pump packing made for the most severe hydraulic service.



Put up in coil or ring form.

ECLIPSE TUBULAR GASKETS are made for hand hole or man hole. It is the ideal gasket and will last for years. It is Rainbow in tubular form.

"RAINBESTO" is the best High Pressure Packing made. It will stand the highest steam pressures. Made in spiral, ring, coil form.

"4810" AIR HOSE is the lightest, most flexible and durable hose for any service where air is used. One length will convince you that it is a "kost kutter."

Buy Peerless Hose for air, water, acids, or steam.

PEERLESS BELTING for conveying, elevating and power transmission is in a class of its own.

RAINBOW is the name of that red belt that costs less and lasts longer than leather.

Peerless make: Belting, Packing, Hose, Moulded Goods, Sheet Rubber Tiling and Rubber Pump Valves of the best quality materials and the right construction.

Our engineers will help you solve any problem regarding the use of our products.

Send For Our Complete Catalogue.

QUAKER CITY RUBBER COMPANY

PHILADELPHIA, PA.

Branches
CHICAGO PITTSBURGH NEW YORK

Manufacturers of

High Grade Rubber Belting, Hose, Packings, and Rubber Goods for Mechanical Purposes

Products.

Belting—(For the Transmission of Power; Conveying of Materials, Coal, Coke, Ores, Gravel, Cement, Sand, Grain, etc.)

Hose—for all purposes (Steam, Water, Air Drill, Pneumatic Tool, Fire, Mill, Chemical, Acid, Suction, Oil, Sand Blast, Coke, Boiler Washout, Turbine, etc.)

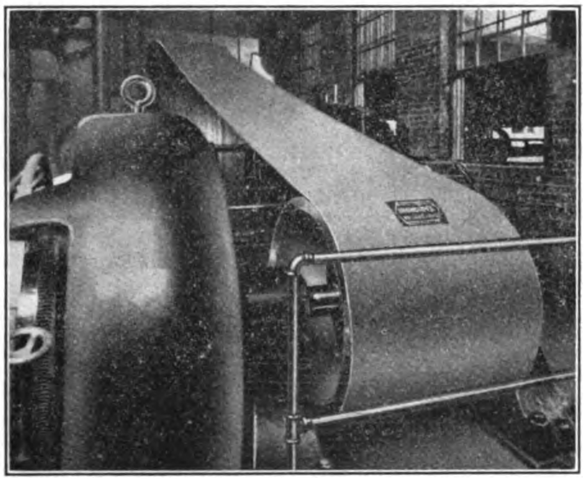
Packings —for Piston, Pump and Valve Rods of all descriptions, and in Sheet Form for Joints and Flanges.

Pump Valves, Gaskets, Tubing, Dredging Sleeves, Mats and Matting, Moulded Goods, etc. Automobile Tires and Tubes.

Complete Catalogue sent on request, address Desk C.

Rubber Transmission Belting.

Rubber Belting is superior to other kinds of belting, as it is made of uniform width and thickness, and can be used in dry, damp or wet places, and can be exposed to the weather. In cost it is much lower than leather, grips the pulley firmly and does not have the tendency to slip.



36" 10-Ply IRONSIDES drives this air compressor day and night.

IRONSIDES is a frictioned surface belt in a class of its own, being the ultimate in belt quality. The plies will not seperate and the surface texture insures the maximum tractive power.

QUAKER CITY—A superior belt manufactured with the most scrupulous care. Made on 32 oz. cotton duck especially woven to stand great strain.

CROWN—A strictly high grade belt. For use where conditions are not extraordinarily severe this belt will give entire satisfaction.

Rubber Conveyer Belting.

For the conveying of ore, sand, gravel, stone, coal, grain, etc.

Conveyer belting can be furnished on short notice for any purpose, any length, width or thickness desired.

Every detail in the manufacture is given special factory inspection. In the construction, extra heavy duck with exceptionally strong friction is used. The quality of the cover on both the carrying and pulley sides of the belt insures the maximum of service, as it will withstand the action of the material conveyed and the wear from the pulleys.

Furnished with reinforced cover on the conveying side, varying from one sixteenth to one fourth inch according to the class of work required.

Desert—Conveyor Belt is designed to give maximum service under conditions that would make the use of lower grade belting considerably more expensive in the end. The cover of this belt is made of a compound that successfully withstands the wearing effects of the materials handled; the duck is a special weave of extraordinary weight, frictioned with a tenaciously gripping friction. In all the essentials of a belt for conveying purposes, DESERT is easily the leader.

Crown—is for general service under conditions that ordinarily wear out belts quickly.

Hercules—is a thoroughly good belt for the lighter class of conveying duty, i. e. where the work is not continuous or the material handled is not of an abrasive or destructive character.

Daniel's P. P. P. Rod Packing

This unquestionably is the finest rod packing. It is the original and only genuine self-setting rod packing on the market. Unequalled for the packing against steam, water, air, ammonia and other fluids on engines, pump and compressor rods, etc. Furnished in all sizes from 3-16" up.

Ebonite Sheet Packing

Ebonite has been found to be the most serviceable packing for high pressures, superheated steam, hot water, ammonia, oils, acids and all other kinds of joints requiring packing.

Furnished in rolls 36 inches wide and in thicknesses of 1-32, 1-16, 3-32, 1-8, 3-16 and 1-4 inch. Also wire and cloth insertion if desired.

Trade Mark
Reg. U. S. Pat. Off.

Packings

Of all kinds for piston and valve rods in ring, spiral or coil forms. Sheet packing for flanges and joints.

Hose

For every purpose. Each grade and brand is made with special care to render the best service for which it is intended. Water, Steam, Air Drill, Pneumatic Tool, Fire Protection, both indoor and outdoor, Suction, Mill, Chemical, Oil, Sand Blast, Coke, Boiler Washout, etc.

Pump Valves

Valves for hot or cold water, ammonia, acids, oils, air, condensers, blowing engines, boiler feed-water pumps, mine pumps, marine pumps, air pumps, etc.

There is a Quaker valve specifically made for every purpose to perform a certain duty. Give conditions where valves are to be used, also size required, and the valve that will give maximum service will be furnished.

Moulded Goods, Mats and Matting, Gaskets, Tubing, Washers, Diaphragms, etc., etc.

DODGE SALES & ENGINEERING CO

General Offices
MISHAWAKA, IND.
Dealers Carry Complete Stocks in All Principal Cities
Manufacturing Plants
MISHAWAKA, IND. ONEIDA, N. Y.

DISTRIBUTORS OF THE PRODUCTS OF
DODGE MANUFACTURING COMPANY AND DODGE STEEL PULLEY CORPORATION

Power Transmission Machinery

Products

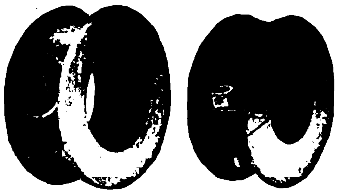
Safety Collars; Keyless Compression Couplings; Adjustable Ball and Socket Drop Hangers; Bearings; Friction Clutches; Pulley: "Independence" Wood Split, "Standard" Split Iron, Iron Center Wood Rim, Oneida, Keystone and National Steel; Cast Iron Gearing, Etc.

Engineers

Through more than 30 years' experience in meeting transmission problems in every line of industry, Dodge engineers are prepared to give most competent service in the selection and arrangement of transmission equipment for maximum efficiency and economy.

Dodge Safety Collars

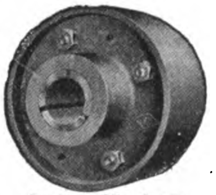
Dodge safety collar are made solid and split for all sizes of shafting, and comply with all the legal requirements as to safety by having set screws and bolts protected. Finished and polished on periphery and faced on ends.



Solid Split
Dodge Safety Collars.

Dodge Keyless Compression Couplings

The design of the Dodge coupling is excellent and its construction so simple that an ordinary workman can erect it as satisfactorily as a skilled mechanic or millwright. The only care needed is to tighten all bolts gradually and evenly to insure true running.



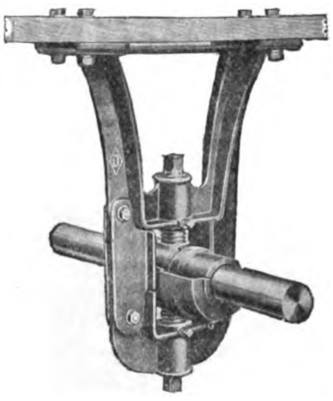
Dodge Keyless Compression Couplings.

Dodge Adjustable Ball and Socket Drop Post Hangers and Bearings

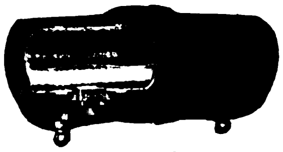
Capillary Type—This bearing is mechanically and scientifically correct in every detail. The Dodge patent capillary oiler is a wooden block, with alternate saw cuts, through which the oil rises by capillary attraction from reservoir to the shaft. The capillary oiler is a non-agitating oiler. There is not the slightest whipping and churning of the oil. Any sediment precipitates to the bottom of the reservoir and only the good clean oil is brought up to the shaft. The action of the capillary oiler is definite and positive and can be absolutely relied upon. It can not fail.

Ring Type—In this bearing the well-known method of oiling by rings is employed, in connection with a bearing of the most superior design and finish.

Standard Type—This plain oiling type of bearing is exceptionally well made for a bearing of this kind, and is relatively inexpensive.

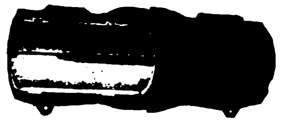


Dodge Adjustable Ball and Socket Drop Hangers.



Capillary Type.

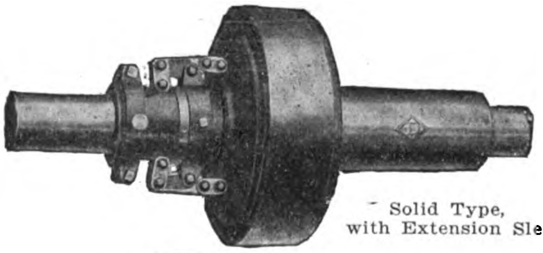
Ring Type.



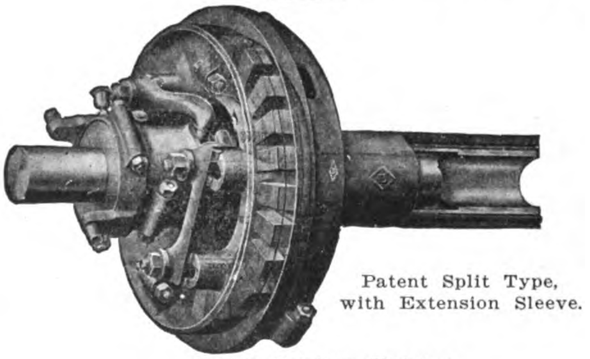
Standard Type.
Types of Bearings used in Dodge Hangers.

Dodge Friction Clutches

These clutches are manufactured also in the form of cut-off couplings. All sizes, to meet all conditions of service.



Solid Type, with Extension Sleeve.



Patent Split Type, with Extension Sleeve.

Dodge Friction Clutches.

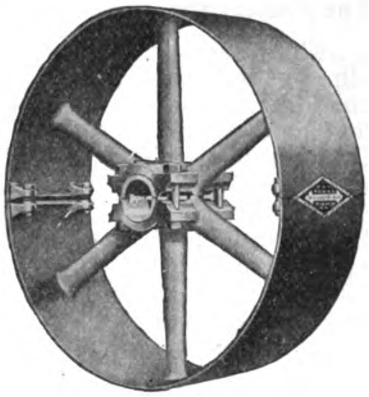
Dodge "Independence" Wood Split Pulleys

Dodge "Independence" Wood Split Pulley.

Rim machined inside and out. Pulley is accurately balanced, runs true, grips shaft securely and has greater transmitting efficiency than any metal pulley.

Made in all sizes and carried in large stocks for instant shipment by all branches and by hundreds of leading dealers. Special sizes made and shipped within 24 to 48 hours from receipt of order.

Dodge "Standard" Split Iron Pulley

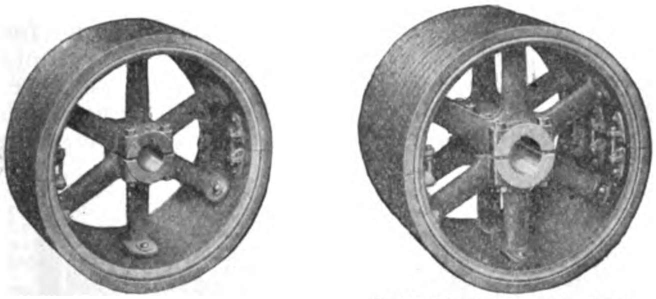


Dodge "Standard" Split Iron Pulley.

Carried in stock. Made with interchangeable metallic bushings.

Dodge Iron Center Wood Rim Pulley

For heavy and shock loads, for high and absolute speeds, this pulley is supreme. Rim is machined inside and out. Pulley is carefully balanced and accurately finished in every detail, and is made solid or split.

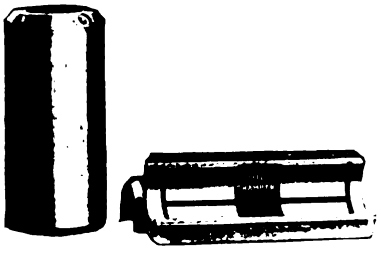


Split Type—Single Arm. Split Type—Double Arm.

Dodge Iron Center Wood Rim Pulleys.

Split Bushings

For tight and loose pulleys. Very easily placed upon the shaft with split pulleys, without necessity of taking down shafting or disturbing any equipment.

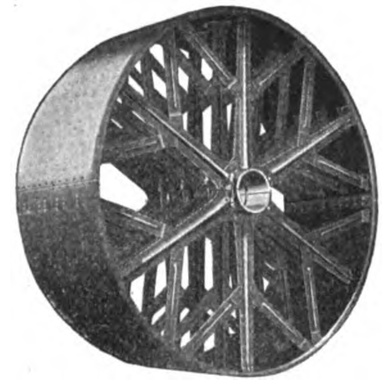


Split Bushings.

Cast in one piece, bored and turned and then split by fracture, the uneven, ragged edges bring the two halves together to a smooth, accurate fit, held in secure position by compression of the pulley hub.

A large reservoir in center holds lubricating oil. Circular and lengthwise gains distribute oil evenly in bearings, returning it to oil chamber when pulley is not in motion. Oil chamber is filled through a convenient spring oiler.

Main Drive Oneidas



Oneida Main Drive Pulley.

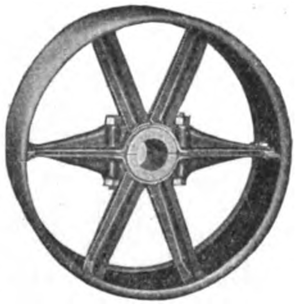
Mute evidence that the Oneida design is basically correct is found in the fact that this as the only steel split pulley that is, or can be, successfully built in sizes up to 14 ft. diameter, for main drive purposes.

Oneida main drives of 168 ins. diameter, with 40-in. face, are driving as high as 750 H. P., with absolute safety and satisfaction. Several thousands of there mammoth Oneida pulleys are in constant use, under a wide variety of conditions.

Oneida Steel Split Pulley

Strength with Light Weight—The lightest belt pulley made—and the strongest. No revolving superfluous pulley weight. Less weight, less friction in shaft journals—and less power loss.

Perfect Oval Crown—Greatest possible belt grip or adhesion. Transmits maximum power at minimum expense of belt pull or tension. Loose belts mean less bearing friction and saving of belts.



As made in sizes 12 to 20 ins. inclusive, in diameter. Takes "G" hub, with standard bore of 3½ ins.

Strong Windcutting Arms—Securely riveted to broad bearing of special fishplates. Stronger than wood and cast iron, but set edgewise, offering little resistance to air.

Double Arms—Oneida pulleys are built "double arm" or "double spider" in sizes beginning at 8-in. face in the smaller sizes, 10-in. and 12-in. face in medium sizes, and 14-in. face in larger sizes.

Rivets that Can Not Shear—Metals first stamped male and female—no lateral or shearing strain on rivets.

No Set Screws or Keyways—Pulley held to shaft by compression of hub. No mutilated shafts, or pulleys running out of true.

Superiority of Dodge Products

The Dodge line is the most complete, highly developed and thoroughly standardized line of power transmission machinery. Besides many other products such as illustrated here, the Dodge line also includes everything for the mechanical transmission of power and the continuous handling of materials.

Prices

Use standard steel pulley list. Send for catalogue, price list and discounts.

Catalogues

Complete illustrated catalogues, containing price, part and dimension lists, and valuable engineering data, may be had promptly for the asking.

CLING-SURFACE COMPANY

1015 Niagara Street; Buffalo, N. Y.

BRANCH OFFICES AND AGENTS ALL OVER THE WORLD.

Manufacturers of

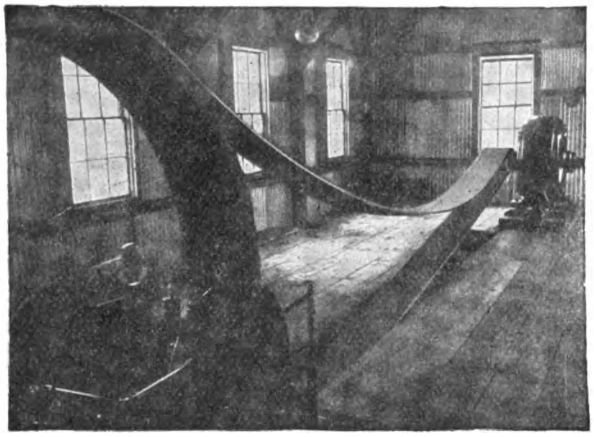
BELT PRESERVATIVE

Product

Cling-Surface for the treatment of belts and ropes. A semi-liquid, free from rosin, acids or other harmful elements, not sticky or gummy, and in ordinary temperatures applied without heating.

A Basis For Scientific Belt Management

Prof. R. C. Carpenter proved at Cornell University that Cling-Surface is instrumental in effecting substantial increases in efficiency in belt transmission.



14 in. motor belt transmitting 100 h. p. to air compressor in a mine plant. Under Cling-Surface treatment this belt runs so slack that the sides nearly touch, yet there is no slip.

Cling-Surface furnishes a basis for intelligent systematic treatment of transmission belting and ropes on main engine, motor, pump and compressor drives, etc., for ultimate as well as immediate efficiency and economy.

While primarily keeping belts, ropes and conveyor belts preserved, pliable, waterproofed and always in the best condition, Cling-Surface treatment is even more useful in keeping internal friction at a constant minimum.

The Improvements Effected Outside Of the Belts

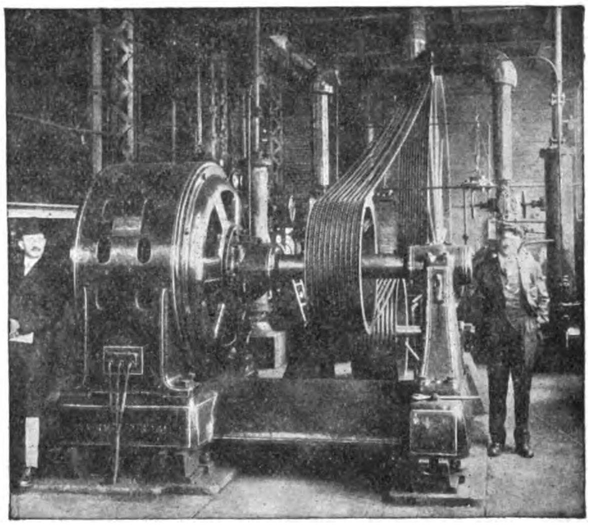
A belt treated with Cling-Surface may be eased or slackened, yet pulls its load without slip and without other initial tension than produced by the weight of the belt. The strain on the belt, shafting, hangers, pulleys, engine and man in charge is thus greatly relieved, while journal friction is reduced to the minimum, which of course means a decided saving of power, lubricants, bearings, and attention, and a lessened danger of shutdowns.

The Preservative Action

Cling-Surface prolongs belt life and prevents slip by penetrating, surrounding and lubricating each internal fibre, making the interior flexible, and leaving the surface mellow, clinging and clean. It is a food to take the place of the natural belt lubrication as this becomes spent. Thus internal drying out and surface cracking and burning are effectively prevented and the entire belt is rendered impervious to moisture, steam, climatic changes and the like, and dust or oil falling upon the surface are less apt to interfere with transmission. The action of Cling-Surface is equally beneficial for all kinds of leather, painted and unpainted canvas, and camel hair belts and can also be used for good balata and rubber belts.

The Effect On Ropes

Cling-Surface treatment does everything for rope drives that it does for belting. It prevents rotting by preventing the penetration of moisture. It produces within a sliding action to replace the grinding that ordinarily disintegrates the core fibres. The improved contact between ropes and sheaves permits a reduction of weight on the tightener, and thus also a noticeable power saving and lengthening of rope life is effected.



Cling-Surface-treated rope transmitting 200 h. p. Ten 1⅛ in. ropes 38 in. sheave on motor. 22 ft. sheave on 54 r. p. m. compressor. Cling-Surface caused the tension weights to be reduced about 25 per cent.

GEM MANUFACTURING CO.

Offices & Works Pittsburgh, Pa.

Manufacturers of

GEM GUARANTEE GOODS

Products

Hand Oilers, Steel Brass Oilers, Heavy Brazed Steel Oilers,
Cadgers
Mine and Pit Car Oilers
Fillers
Tallow Pits
Grease Buckets
Oil Cans
Shop Torches
Flue Scrapers
Locomotive Oilers
Flexible Shafting and Attachments
Counter Shafts
Breast Drills and Drill Presses
Universal Joints
Portable Grinders and Drills, Motor or Rope Drive for Special Mine Work.

We make a specialty of Rush Orders for machine work.

MR. MINE SUPERINTENDENT OR PURCHASING AGENT, upon request, we will send you Catalogue No. 8, giving complete description of the above mentioned products, also samples of Brazed Seam Oilers, Torches and Oil Cans free of charge.

BRAZED SEAM GOODS are economical, because of their durable construction. To braze our products, it takes 1800 degrees of heat, whereas the ordinary solf-soldered competitve goods are soldered at 350 degrees heat.

Brazed Seam goods can be heated to a red heat without causing them to leak. Although the initial cost of Brazed Seam goods is a little higher, in the end they are the most economical. One Brazed Seam Oiler, Torch, or any other Brazed Seam article, will last from five to ten times longer than the ordinary competitive article.

Heavy Brazed Steel Tallow Pots

No.		List Pr. per doz.
45 H.	1-qt. Tallow Pot..	$13.00
47 H.	2-qt. Tallow Pot..	15.00
48 H.	3-qt. Tallow Pot..	17.00
49 H.	4-qt. Tallow Pot..	18.00
With Strainers, extra		2.50

Are so constructed that strainers are removable.

You cannot injure these Tallow Pots by placing them on a fire to heat the tallow.

Heavy Brazed Steel Oil Carriers

	Screw Top	List Price, Each
No. 60 H.	1-gallon Carrier..........	$2.00
No. 61 H.	2-gallon Carrier..........	2.50
No. 62 H.	3-gallon Carrier..........	3.00
No. 63 H.	4-gallon Carrier..........	3.50
No. 64 H.	5-gallon Carrier..........	4.00
With Strainer, extra........................		.25

Are so constructed that Strainers are removable.

Any capacity of larger sizes made to order.

Very heavy steel.

Extra heavy bail and lugs.

Seams hard spelter brazed.

For factory and railway use.

It is perfectly safe for storage.

Heavy Brazed Steel Pyramid Torches

		List Price, Per doz.
No. 80 H.	⅙-pt. 1 burner Pyramid Torch.	$ 7.00
No. 81 H.	1-pt. 1 burner Pyramid Torch	9.00
No. 82 H.	1-qt. 1 burner Pyramid Torch	10.00
No. 83 H.	1-qt. 2 burner Pyramid Torch	11.00
No. 84 H.	2-qt. 1 burner Pyramid Torch	12.00

You cannot secure a stronger Torch than those we manufacture.

Guaranteed not to leak.

Seams heavy spelter brazed.

Extra heavy handle, securely riveted .

Drawn steel tops

For factories, foundries, rolling mills, blast furnaces, construction work, is a stout, durable Torch.

Gem Plain Brazed Steel Bench Oilers

Tempered Steel Bottoms

	Capacity	Spout	Diam.	List Price Per doz.
No. 1603.	⅓ pt.	3 in.	3⅜ in.	$4.75
No. 1604.	⅓ pt.	4 in.	3⅜ in.	5.00
No. 1606.	⅓ pt.	6 in.	3⅜ in.	5.50
No. 1609.	⅓ pt.	9 in.	3⅜ in.	6.00
No. 1703.	½ pt.	3 in.	3¾ in.	5.75
No. 1704.	½ pt.	4 in.	3¾ in.	6.00
No. 1709.	½ pt.	6 in.	3¾ in.	6.50
No. 1709.	½ pt.	9 in.	3¾ in.	7.00
No. 1803.	¾ pt.	3 in.	4⅛ in.	6.75
No. 1804.	¾ pt.	4 in.	4⅛ in.	7.00
No. 1806.	¾ pt.	6 in.	4⅛ in.	7.50
No. 1809.	¾ pt.	9 in.	4⅛ in.	8.00
No. 1903.	1 pt.	3 in.	4½ in.	7.75
No. 1904.	1 pt.	4 in.	4½ in.	8.00
No. 1906.	1 pt.	6 in.	4½ in.	8.50
No. 1909.	1 pt.	9 in.	4½ in.	9.00

The 6 and 9 inch spouts are furnished bent unless otherwise ordered.

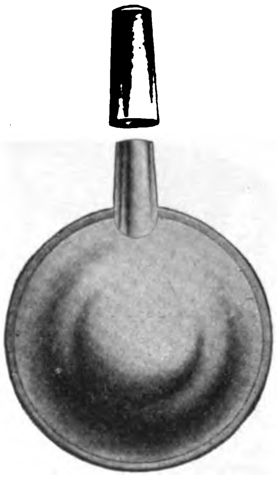
Oilers are made of No. 20 B. & S. gauge COLD ROLLED STEEL. All highly polished. GUARANTEED.

Bushings of solid brass castings, machine cut.

Leather washers are cut from split sides.

All lengths of spouts are interchangeable.

Oilers copper or nickel plated to order.



Gem Steel Cadger

A strong and durable carrier for miners' reserve oil supply. Made of heavy cold rolled steel, with double rolled side seam spelter brazed. Heavy tapered spout, spelter brazed to body of can, with tapered cap of same gauge, making tight joint without screw thread.

Cap easily removed.

Practically indestructible.

Will outlast half a dozen ordinary tin Cadgers, and costs but little more than one.

Fits the pocket.

Always with you.

½-pt., per gross, list price....$36.00

Heavy Brazed Steel Mammoth Or Pit Car Oilers

		List price
No. 36 H.	1-qt. Pit Car Oiler, 8 in. spout,	$16.00
No. 37 H.	2-qt. Pit Car Oiler, 10 in. spout,	18.00
No. 38 H.	3-qt. Pit Car Oiler, 12 in. spout,	21.00
No. 39 H.	4-qt. Pit Car Oiler, 12 in. spout,	24.00

All spouts furnished straight unless ordered bent.

Any length spout, straight or bent. Sizes all interchangeable. Large opening for heavy oils.

EXTRA NOZZLES

Length, inches	8	10	12	18
Price, per dozen	$2.75	3.00	3.25	3.50

Guaranteed not to leak. Seams hard spelter brazed.

Do not compare the above goods with the ordinary soft soldered, light steel or tin oilers.

Write for Discounts.

WIILLIAM RENTON, INCORPORATED

101-103 Water Street
PITTSBURGH, PA

Cylinders Rebored in Present Position

Cylinders

We re-bore cylinders in their present position for Steam, Mining, Blowing, Hoisting, Pumping, Hydraulic and Gas Engines, Cylinders for Steam Hammers, Air Compressors and Refrigerating Machines, Etc.

Fly Wheels, Gear Wheels, Etc.

We also re-bore in present position Fly Wheels, Housens, Large Gear Wheels, Bearings for Shafts, Engine Guides, Corliss Valve Seats, Piston Valve Seats, Bushings, Etc.

For Quick Service.

To save time, we frequently send our men to your plant, measure up the Cylinder for new Piston Heads, Rods and Packing and have them on the ground, when the boring is done, ready to put in the Cylinder, thus saving Time, Labor and Expense.

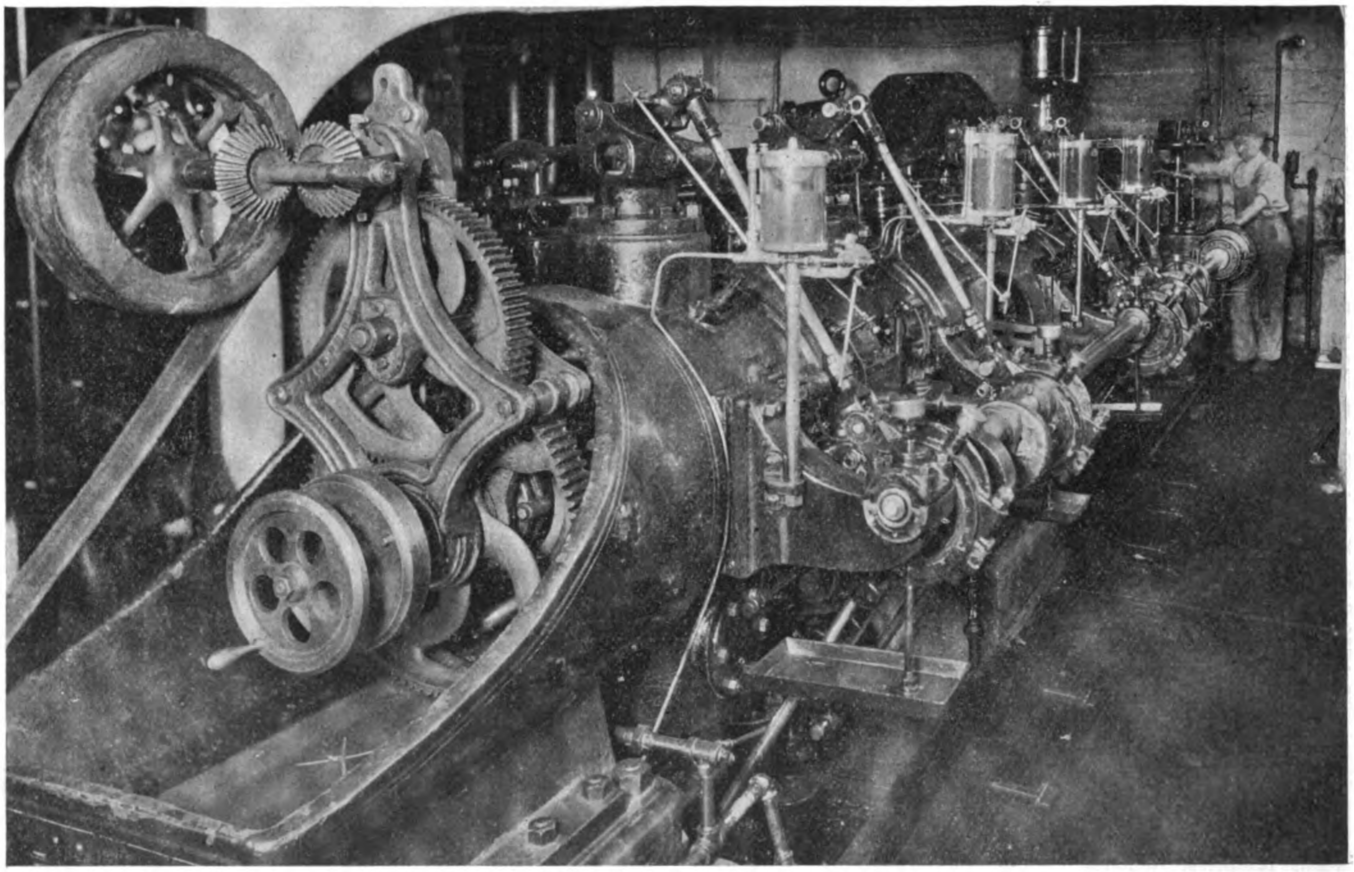
Bushings.

Should you desire to have your Cylinders rebored and bushings, either Cast Iron, Brass or Steel furnished to fit same, we are enable to do quick work and make a good job.

At Your Plant.

At your plant, we can re-bore your Cylinders,, upright or horizontal, re-bore the Corliss Valve Seats, Plane up Slide Valve Seats, re-bore Wrist Pin Holes, either straight or taper, turn up the Wrist Pin bearings, re-bore your Engine Guides, Babbitt and rebore the bearings for your Engine Shaft, Etc.

Corliss and Other Makes of Engines Repaired Promptly.



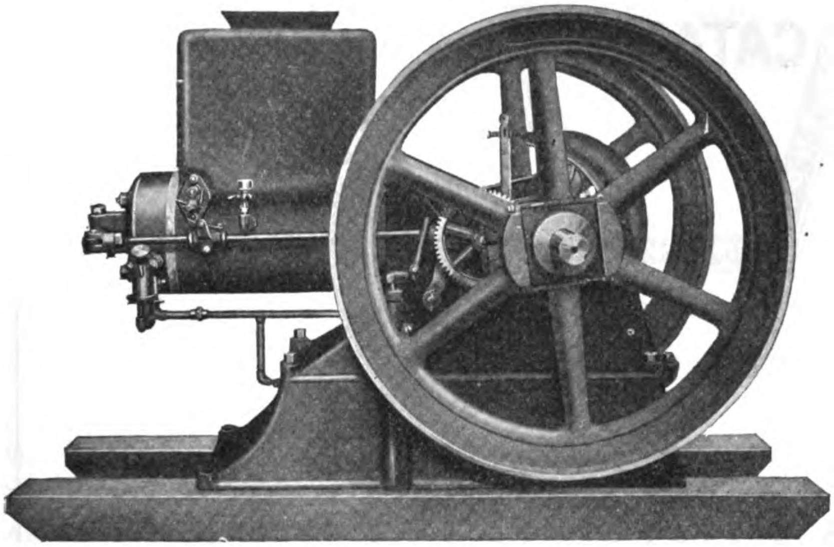
HARRIS PUMP & SUPPLY CO.

320-322 Second Ave. PITTSBURGH, PA.

Pumps and Hydraulic Machinery

Gasoline Engines New Electric Motors

In Stock-Immediate Shipments



Stover's Good Engines—
Gas, Gasoline or Kerosene

We carry in Pittsburgh stock a complete line of Stover engines. These engines run in size from ½ H. P. to 60 H. P. We can positively guarantee any of them to give satisfactory service at all times. We would be pleased to have your inquiries when in the market for this type of equipment.

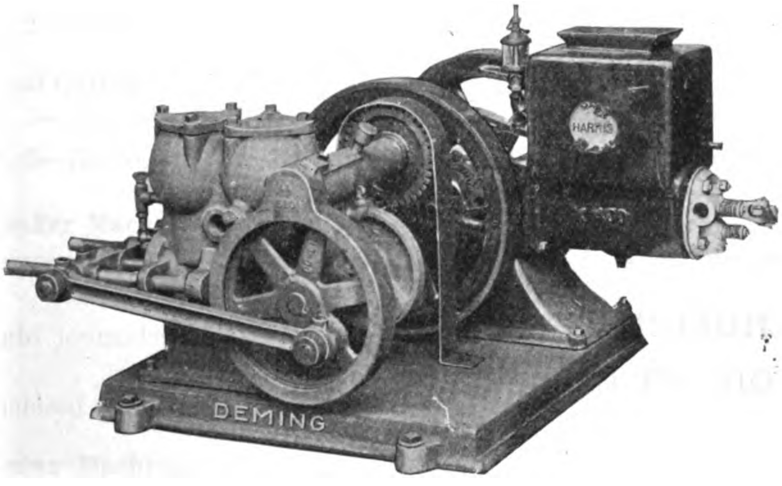


Fig. 2196

Electric Motors

We carry in Pittsburgh one of the largest stock of brand new motors carried by anyone in the country, running in size from ½ H. P. to 125 H. P., both Westinghouse or General Electric and other makes. Send us your inquiries.

The illustration, Fig. 2196, is a small pumping outfit, which will give a capacity from 480 to 600 gallons per hour, good for 75 bl. pressure.

In this outfit we would use a 1½ H. P. Stover engine directly connected to a 2¼ x 5 Deming Atlas pump.

As we carry all of this material in stock it means prompt deliveries from Pittsburgh.

SEE PAGES 560 TO 567 AND 578, DEMING & MORRIS PUMPS IN STOCK AT PITTSBURGH FOR IMMEDIATE SHIPMENT

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

LUBRICATING SECTION

The following manufacturers have catalogue descriptions in this section:

Atlantic Refining Co.
Cataract Refining & Mfg. Co.
Dixon, Joseph Crucible Co.
Keystone Lubricating Co.
New York & New Jersey Lubricating Co.
Ohio Grease Co.
United States Graphite Co.
Wayne Oil Tank & Pump Co., The.

For additional descriptions of Lubricants, not appearing in this section, refer to Index of Products in front of book.

THE ATLANTIC REFINING COMPANY

PHILADELPHIA PITTSBURGH

Lubricants and Service

Lubrication

Conditions met at one mine are not exactly like those found at another mine. This applies powerfully to the lubrication of the various machine units, even when of the same type and make. Consequently a single lubricant for any class of machinery may not give maximum efficiency universally.

Service

Atlantic Lubricants are many in number, made to meet every mine condition. Their proper selection is an engineering problem which we should be glad to solve with you.

For some average conditions, as listed below, we make the following recommendations:

CONDITIONS AND EQUIPMENT.	RECOMMENDATIONS.
Journals:	
Medium speed and load, drop feed oiling	Atlantic Red Engine Oil.
Low speed, heavy load, drop feed oiling	Kearsarge Engine Oil. Atreco Heavy Duty Engine Oil.
Medium speed, light load, reservoir or continuous flow	Renown Engine Oil. Junior Red Engine Oil.
High speed, light to medium load, reservoir or continuous flow oiling	Premier Turbine Oil. Renown Engine Oil.
Cylinders:	
Saturated Steam, medium pressure, medium and heavy duty	Capitol Cylinder Oil.
Superheated steam, above 600° F, heavy duty, horizontal	Atlantic Superheat Cylinder Oil.
Air Compressors:	
No. 1—Very high pressure	Argon Compressor Oil.
No. 2—Medium or low pressure air	Ario Compressor Oil.
Metal Cutting:	
No. 1—Threads—Pipe and general machine shop practice	Union Thread Cutting Oil.
No. 2—Lathe, shaper and general steel cutting operations	Union Thread Cutting Oil or Atlantic Soluble Cutting Oil.
Breaker Machinery:	
Heavy slow speed journals, equipped with compression grease cups	Heavy Journal Oil. Arctic Cup Grease.
Light journals fed through oil holes or oil reservoir	Light Journal Oil. Summer Lubricating Oil. Winter Lubricating Oil.
Enclosed pinions and bevel gear drives	Arctic Cup Grease or Dark Gear Grease.
Mining Machines:	Renown Engine Oil or Golden Mining Machine Oil.
Mine Car Wheels:	
Plain wheels, old type	Summer Lubricating Oil. Winter Lubricating Oil.
Roller bearings or cavity type wheels	Eureka Grease for Mine Cars, light or heavy grade.
Wire Cables:	No. 2 Liquid Cable Coating. Atreco Cable Coating.
Illumination:	
Illuminants that are portable and easily obtained, that produce a flame not readily extinguished by draughts, that do not give off poisonous gases	Atlantic Miners Oil. Miners Sunshine.
Safety Lamps:	Ideal Safety Lamp Oil. Peerless Safety Lamp Oil.

Specify Atlantic Lubricants and Receive Atlantic Service For Economical Operation.

JOSEPH DIXON CRUCIBLE COMPANY

JERSEY CITY, N. J.
PHILADELPHIA BRANCH, 1020 ARCH ST.

D X N TRADE MARK

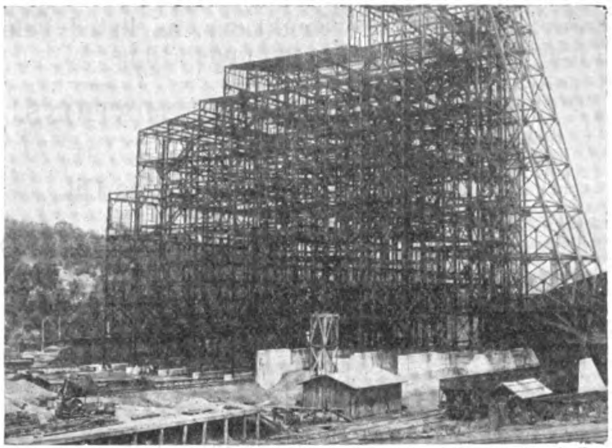
Dixon's Graphite Productions

D X N TRADE MARK

Dixon's Silica-Graphite Paint

"The One Quality Paint"

Measured by years of service, Dixon's Silica-Graphite Paint is more economical than any other protective paint. It is recommended and used extensively for the preservation of all steel and iron structures.



Wanamite Breaker of the Lehigh & Wilkes-Barre Coal Co., Wanamie, Pa. All structural steel preserved by Dixon's Silica-Graphite Paint.

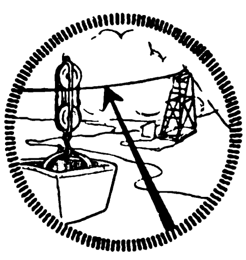
Dixon's Waterproof Graphite Grease

Composed of high grade petroleum grease with which is incorporated a certain proportion of DIXON'S SELECTED FLAKE GRAPHITE.

For Pump Plungers

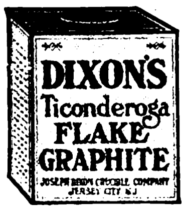
It will not wash off the rod (providing rod is dry when application is made). It stays there and lubricates. MINE PUMPS handling acid, alkaline or dirty water take a new lease on life when this grease is used, because it effectually protects the packing and prevents scoring of the rods. The graphite is there for severe service when trouble comes.

For Wire Ropes



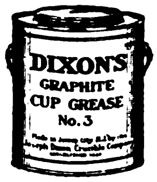
The most perfect source of protection against both wear and corrosion of wire ropes is Dixon's Waterproof Graphite Grease. It penetrates to the innermost strands, keeps them well lubricated and thus minimizes internal friction. Being insoluble in water and unaffected by acids, alkalies, or corroding atmospheric conditions, this grease "stays" with the rope and guards against all damaging influences.

Dixon's Ticonderoga Flake Graphite



Of great value as a lubricant for cylinders, valves and bearings, either alone or mixed with oils and greases. Indispensable for coating gaskets and packing.

Dixon's Graphite Cup Greases



Due to the flake graphite in these greases, they give longer and better service than is possible with ordinary cup greases. Prepared in six degress of hardness.

Dixon's Graphite Brushes

For dynamos and motors. Prevent wear of the segments, save resurfacing of the commutator, stop sparking and pitting. Give most satisfactory service.

Dixon's Graphite Center Plate Grease

For lubricating center and side bearings of cars.

It is a heavy-bodied grease in which is incorporated a suitable proportion of flake graphite, so that long after the grease itself has disappeared from the bearing surfaces, effective lubrication is afforded by the graphite flakes that have become attached to the metal. Its use makes a train flexible and consequently prolongs life of wheels and saves in tractive power.

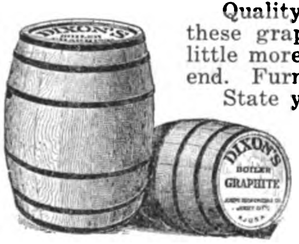
Dixon's Graphite Curve Grease

Dixon's Graphite Curve Grease meets the demand for a durable lubricant for curves and switches at a low price. Saves wear of track and wheel flanges, and is much more economical in all respects than cheap black oils and greases.

In ordering specify whether for winter or summer use.

Lubricants

Prepared in various grades for the lubrication of wheel, journals of electric cars, engines, freight and passenger cars, ore cars, mine cars, etc.



Quality is the keynote of the success of these graphited lubricants. They cost a little more at first but are cheaper in the end. Furnish best service all the time. State your problem.

Dixon's Boiler Graphite

(Fine Flakes)

The Pioneer Boiler Graphite. "It's all in the Flakes."

Its Action—
Purely mechanical.

Its Use—
Lessens the time required for boiler cleaning.
Noticeably increases the steaming capacity.
Reduces fuel consumption.
Minimizes repairs.
Improves operation of feed pumps.
Increases life of valves and gaskets.
Prolongs the life of boilers.

DIXON'S
ELDORADO
"The master drawing pencil"
ELDORADO - the master drawing pencil

Circulars giving detailed information on above sent on request.

CATARACT REFINING & MFG. CO.

General Offices,
Marine Nat'l Bank Bldg. BUFFALO, N. Y

Eastern Dep't Offices,
17 Battery Place, New York City.

Western Dep't Offices,
327 So. La Salle St., Chicago.

Plants,
Buffalo and Chicago

Warehouses,
New York, Boston, Buffalo, Detroit, Chicago, San Francisco, Toronto, Canada.

"OUR MOTTO"—Give the buyer a product suitable for all mechanical and climatic conditions, which for quality and price is unexcelled.

MINE LUBRICANTS

MINE CAR LUBRICANTS

Calypsol Mine Car Grease
Made in suitable consistencies for plain or roller bearing type wheels.

Calypsol Car Journal Grease and Car Journal Yarn
For open boxes where a yarn packing is required.

Plumbago Hair Car Grease
A combined packing and lubricant for open boxes.

PLUNGER GREASE

Plumbago Lubricant
A high-grade graphite grease for pump plungers.

BISON CAP SYSTEM

Bison Shafting Grease and Yarn
For line shafting, fan bearings and other journals, in connection with Bison Cap System of Lubrication.

CABLES, CHAINS AND GEARS

Bison Chain, Gear and Cable Dressing
An adhesive, waterproof lubricating dressing.

WATERPROOF GRAPHITE GREASE

Plumbago Lubricant
(All consistencies) For General use when a graphite or waterproof grease is desired.

COMPRESSION CUP GREASES

Monarch Lubricant	Nos. 3, 4 or 5.
Calypsol Compound	No. 62.

DRILLS

Bison Transmission Grease
No. 70 for air drills.
No. 72 for electric drills.

RING, CHAIN AND COLLAR OILER BEARINGS

Calypsol No. 90 or 91 Grease.

SPECIAL GREASE GUNS for mine car and ring oiler greases always in stock.

Our line is recognized as the most complete in quality and variety offered the public. Our greases are manufactured in our own plants at Buffalo and Chicago, assuring the buyer of the manufacturer's personal supervision.

Special and more complete information furnished upon application.

KEYSTONE LUBRICATING CO.

21st., Lippincott and Clearfield Streets,
PHILADELPHIA, PA.
ESTABLISHED 1884.

BRANCHES, OFFICES AND WAREHOUSES:

NEW YORK	1777 Broadway	BOSTON	141 Milk Street
CHICAGO	3633 to 3645 So. Racine Ave.	DENVER	First National Bank Building
NEW ORLEANS	609-15 Chartres Street	SAN FRANCISCO	268 Market Street
PITTSBURGH	Jenkins Arcade	SAVANNAH	141 Drayton Street

The principal branch office for the bituminous coal fields is located in the Jenkins Arcade, Pittsburgh, Pa., where extensive Sales and Mechanical Engineering Departments are equipped to render valuable service to the coal mining industry.

Agencies in the Principal Countries Throughout the World

General Office and Warehouse for Great Britain, Manchester, England.
Continental European Office, Paris, France.
West Indian Office, Havana, Cuba.
Canadian Offices, Montreal, Canada; Halifax, Nova Scotia.

Manufacturers of Petroleum Lubricants

Products

Keystone Grease (several densities), Keystone Wool Yarn Grease, Keystone Turbine Oil, Keystone Cylinder Oil, Keystone Motor Oil, Keystone Gas Engine Oil, Velox Gear Grease, Keystone Wire Cable and Manilla Rope Greases. Keystone Grease is made in different densities for various uses and is suitable for use on every type of machinery, whether light or heavy, high or low-speed. It will not change consistency under either ordinary or extremely severe working loads and temperatures. The same density is used both summer and winter, since it is not affected by atmospheric changes of heat or cold.

Keystone Grease possesses the much-desired clinging quality that oils and animal oil greases lack. It tends naturally to stay in the bearings and will keep them cool at extremely severe as well as moderate loads. Keystone Grease does not soften and cannot be fed exactly as are animal oil greases. If a heavy density is forced into the bearings under pressure,—such as feeding through spring automatic or hand compression cups, it forces out grease which would otherwise stay in the bearing indefinitely. Care should therefore be exercised and the grease applied sparingly, for a little Keystone Grease goes a long way.

LUBRICATING MINING MACHINERY EFFICIENTLY.

Motor Lubrication

It requires only efficient lubrication to give to mine locomotives a greatly increased haulage efficiency and much longer life to their bearings. It is easy to demonstrate that Keystone Grease will afford this result at a cost considerably below that of oil or ordinary grease.

Oil naturally runs off nearly as fast as it is applied and generally does not have sufficient body to furnish lubrication for such work, even if it could be retained. Ordinary greases are affected by frictional and electrical heat and sooner or later escape in the same manner.

There is nothing mysterious about the performance of Keystone Grease—it stays in the bearing and every particle of it furnishes lubrication. It does not melt and run off, leaving dry bearings and a trail of oil covered road-bed.

Keystone Grease always has the same consistency regardless of atmospheric conditions of heat and cold, furnishing a constant and even flow of lubricant to every bearing and journal to which it is applied. This naturally makes bearings wear much longer than is possible where lubrication is uneven and intermittent.

We can show you records of lubrication costs decreased by over 50%, with an increased haulage efficiency and lower repair cost.

In use, Keystone grease of proper density is used in all grease cups, with Keystone Wool Yarn grease, and Keystone Wool Yarn Elastic Grease in journal boxes.

Application is simply and easily made.

Arrangements for a conclusive test can be made without obligation.

Mine Car Lubrication

No. 119 Keystone Grease for mine cars has four qualities that are not possessed by any other lubricant of any kind, and they are the reasons for its unusual efficiency in mine car use.

First, it maintains the same density in all working temperatures, whether hot or cold. It consequtly never becomes thin and wastes, nor too thick and fails to feed.

Second, it has an even consistency, never becoming lumpy and clogging the holes leading from the reservoirs.

Third, it is not affected in the least by the chemicals with which mine water is frequently impregnated and is a natural preservative for metals to which it is applied.

Fourth, it's unusually high lubricating properties makes it economical. Its density is such that the small amount required to keep wheel and axle perfectly lubricated are fed to the axle during each rest period. **One filling of the reservoir frequently lasts three to six months and longer, without any attention whatever.**

Hundreds of mines are now using No. 119. Ask any of them what they know about it.

Cable Lubrication

If wire and manilla rope cables are to last and furnish service commensurate with their cost, they must be efficiently protected.

Keystone Wire Cable Grease and Keystone Manilla Rope Transmission Grease are particularly noted for their ability to penetrate the strands to the core and at the same time protect the exterior so that no grit or dirt can work into the cable.

They are not affected by water nor by chemicals in mine water. They are not affected by heat or cold nor will they decompose. Your cables are not getting the treatment they deserve without these particular lubricants.

NEW YORK & NEW JERSEY LUBRICANT CO.

Originators and Sole Manufacturers

TRADE MARK REGISTERED IN
NON-FLUID OIL
UNITED STATES PATENT OFFICE

165 Broadway New York

Products

Non-Fluid Oil—produced in over forty densities, including grades exactly suited to every lubricating condition that is presented in the operation of coal mining and handling machinery.

MoToRoL—For lubricating cylinders of gas engines.

Non-Fluid Mine Car Oil

Medium Grade for Plain Cavity Type Wheels

Is of such consistency that it will feed properly from the oil chamber to the axle under all service conditions. This guards against the excessive friction-load and destructive wear that occur when using car oils, which congeal in winter, or car wheel greases, for these cannot start to lubricate until the heat of the bearing renders them soft enough to flow from the reservoir. On the other hand, Non-Fluid Mine Car Oil is not so light that it will escape from the bearings, and only sufficient lubricant feeds from the reservoir to replace that which is actually worn out. The agitation of the lubricant, caused by the jerking and jarring of the cars in running over rail joints and in taking up slack in the car couplings, facilitates this feeding process. The waste in using car oil is very great, particularly during hot weather, as it pours in a continuous stream from the reservoir to the axle, and is literally "pumped" from the bearing, because of the lost motion between the wheel and the axle.

Non-Fluid Mine Car Oil

Heavy Grade for Roller Bearing Type Wheels

Uniformly maintains a consistency about equal to that of warm vaseline, and can be depended on to keep all the rubbing parts coated with a lubricant film that minimizes frictional resistance and promotes the efficiency of roller bearings in their function of reducing power consumption. Fluid oils fail to render this service, because of their tendency to flow away from frictional points. This fault is aggravated as the bearings warm up, for then the oil is rapidly vaporized and actual metal-to-metal contact takes place over large areas of the bearing surface, resulting in an abnormally high friction-load and rapid wear of the bearings. The constant escaping of oil from the bearings also makes it very wasteful, and necessitates frequent recharging of the oil chamber.

The use of ordinary grease in Roller Bearings should be avoided, because, as is well known, grease must be melted by the heat of the bearing before it can lubricate at all. Since this necessitates an increase in the friction load, it follows that grease in a measure defeats the very object for which roller bearings are installed and is therefore unsuitable for their lubrication. So-called "semi-fluid" or "semi-solid" greases as a rule liquefy in use, and waste as freely as oils, while failing to provide relief from the drawbacks of ordinary grease.

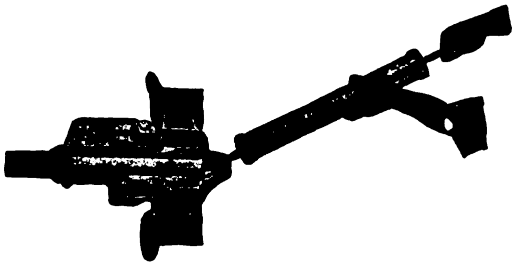
Non-Fluid Mine Car oil is a strictly neutral lubricant and will preserve the finely finished surfaces of the rollers, guarding against the corrosion and pitting that generally occur when ordinary greases are employed, due to the presence of free acid in the lubricant.

If an even heavier density is preferred, Grade No. 120 is recommended. For **car wheels equipped with Hyatt Roller Bearings** the **Light** grade is generally most suitable, although the construction of some makes of wheels, equipped with these bearings, will permit the use of the heavier grades.

When using Non-Fluid Mine Car Oils, all wheels should be fitted with oil plugs.

N. F. O. Mine Car Gun

This gun is designed especially for applying Non-Fluid Mine Car Oils, and will handle all grades with ease, without the removal of spout, making it possible to pack car wheels quickly and without waste of lubricant.



It is of very substantial steel construction and will stand the roughest use. The barrel is 18½" x 2½" and the spout of gun tapers, so that it will fit any oil-hole.

Other Grades of Non-Fluid Oil

are of equally high efficiency for the lubrication of air compressors, box car loaders, car hauls, dynamos, engines, fans, gears, loading booms, mine locomotives, motors, picking tables, pumps, retarding conveyors, revolving dumps, shaker screens, sheaves, wire cables, etc.

Non-Fluid Oil definitely reduces the friction-load of machinery as compared with ordinary grease, and permits the utilization in useful work of a large percentage of power that is generally wasted.

Non-Fluid Oil outlasts the best fluid oils and greases three to five times, reducing the cost of lubrication and the labor and loss of time in oiling.

Non-Fluid Oil does not vary in consistency with changes of temperature, so can be depended on to lubricate efficiently under all service conditions.

LIBERAL TESTING SAMPLES WILL BE FURNISHED FREE, UPON REQUEST.

The results of our thorough research into the lubrication of coal mining machinery, have been embodied in our Bulletin 26A. Write for free copy.

THE OHIO GREASE COMPANY

Main Office and Works,
505 to 625 North Spring St.,
LOUDONVILLE, OHIO

Manufacturers of

The Ohio Brand of Lubricating Greases

Warehouses at

Philadelphia, Pa., Pittsburgh, Pa., Richmond, Va., Cincinnati, Ohio, St. Louis, Mo., Chicago, Ill., Memphis, Tenn., Shreveport, La., New Orleans, La., Kansas City, Mo., San Francisco, Cal., Portland, Ore.

Products

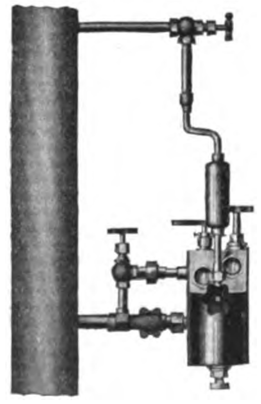
Cylinder Grease, Cup Grease, Fibre Grease, Bearing Grease, Shafting Grease, Journal Grease, Transmission Grease, Auto Grease, Rope Grease, Gear Grease, and Commutator Compound; also Grease Cylinder Lubricators, Superheaters, Compression Cups, and Steel Shafting Cups.

Ohio Cylinder Grease

consists of the highest obtainable grade of Pennsylvania Cylinder Stock scientifically compounded with Acidless Tallow Oil, and highly contrated. It is therefore dependable and efficient at any pressure, and under all conditions; and positively will not carbonize, or leave a residue of any kind to gum cylinders or valves. This grease is now made in six grades, known as 1-V, 2-V, 4-V, 2XL, 4XD, and 5-X, and sells at the following prices, f. o. b. our factory:

Barrels	cotaining about	380 lbs.	@ 12c per lb.
Half-bbls.	" "	225 lbs.	@ 13c per lb.
Kegs	" "	110 lbs.	@ 14c per lb.

Ohio Grease Lubricators



Class "F" Lubricator.

Ohio Cylinder Grease is fed through special lubricators that are furnished absolutely free for the purpose. They are made in several styles and sizes, and are adaptable to all kinds of steam units, giving perfect service under all conditions. These lubricators heat, feed and atomize the grease, thoroughly mixing it with the steam before it enters cylinder, and the result is perfect lubrication without waste.

What This System Accomplishes

This system will save you 30% on the cost of cylinder oil, 50% on packing, overcome all trouble with oil in boilers, and make your steam units run smoother and better than ever. It is doing all this, and more, for hundreds of the largest mines, and we would welcome an opportunity to prove it in your case. Write for test offer.

Ohio Cup Grease

An excellent lubricant for all kinds of machinery bearings, conveyors, etc.

This grease is made in six consistencies ranging from very soft to very hard. These are known as 1-0, 2-0, 3-0, 4-0, 5-0, and 6-0, and are sold at the following prices F. O. B. our factory:

Barrels . .	containing about	380 lbs.	@ 10c per lb.
Half bbls.	" "	225 lbs.	@ 11c per lb.
Kegs	" "	110 lbs.	@ 12c per lb.

Ohio Fibre Grease

A very high melting point grease of a spongy or fibrous nature. These properties enable it to stay where it is put, though the temperature be high, and to outwear ordinary cup or bearing grease.

This grease is made in six consistencies known as No. 1, No. 2, No. 3, No. 4, No. 5 and No. 6. All sell at the folowing prices F. O. B. our factory:

Barrels . .	containing about	380 lbs.	@ 12c per lb.
Half bbls.	" "	225 lbs.	@ 13c per lb.
Kegs	" "	110 lbs.	@ 14c per lb.

Ohio Journal Grease

A superior mineral lubricant for Mine Cars, Electric Cars and Railway Cars. It is made in three consistencies which are designated by the letters, A, B, and C. All are sold at the following prices F. O. B. our factory:

Barrels . .	containing about	380 lbs.	@ 10c per lb.
Half bbls.	" "	225 lbs.	@ 11c per lb.
Kegs	" "	110 lbs.	@ 12c per lb.

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A high grade lubricant for wire ropes or cables. Especially adapted for use on hoisting and haulage ropes. It is sold at the following prices F. O. B. factory:

Barrels	containing about	380 lbs.	@ 8c per lb.
Half bbls.	" "	225 lbs.	@ 9c per lb.
Kegs	" "	110 lbs.	@ 10c per lb.

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All the products manufactured by this company are compounded with the correct proportion of our Mexican Graphite reduced to a powder of impalpable fineness; absolutely free from grit and all abrasive substances.

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A grease especially compounded for use in plain bearing type of cars. Most effective as a lubricant and lasts longer than oils or other greases. The graphite in this grease protects the bearing against cutting and scarring. Is dripless and will not gum or harden.

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Compounded of the finest mineral oils and our graphite and designed for use on roller or ball bearing type of Mine Cars. It is one of the most effective and economical greases that has ever been offered to Coal Mines.

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Made in five colors: Natural, Dark Green, Jet Black, Dark Brown and Dark Red. Will positively protect any exposed wood or metal surface against corrosive influences, such as acids, sulphur fumes, smoke, brine, heat, cold, moisture, etc. Owing to the fineness of the pigment and its purity it will affectively coat more surface per gallon and last longer than any other paint on the market.

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A harmless, effective, mechanical boiler scale remedy. Breaks down old scale regardless of the thickness and hardness in a mechanical manner. Does not affect the metal of boiler but tends to protect it to a certain extent against pitting or corrosion by free acids. With the introduction of this graphite into your boiler scale troubles cease.

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A high grade mineral lubricant suitable for all uses where Cup Grease is desired.

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For use wherever a good grade of Waterproof Grease is desired. Particularly adapted for use in mines.

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For heavy gears and machinery. Especially efficient for use on cog and sprocket wheels, sprocket chains, wire rope, hydraulic water pumps, conveyors, pump plungers, etc.

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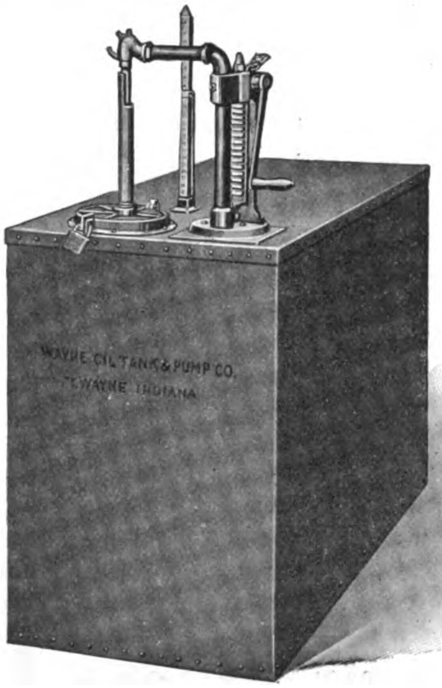
Lubricating oils to be efficient must be kept clean. If dust and dirt are allowed to get into them they will do tremenduous damage in a short time. The dirt is carried into the bearings by the oil, where it will cut and grind like emery dust. The result is damaged bearings and worn out machinery. The Wayne Systems are not only dust-proof but are economical, fire- and fool-proof as well.



Cut No. 37

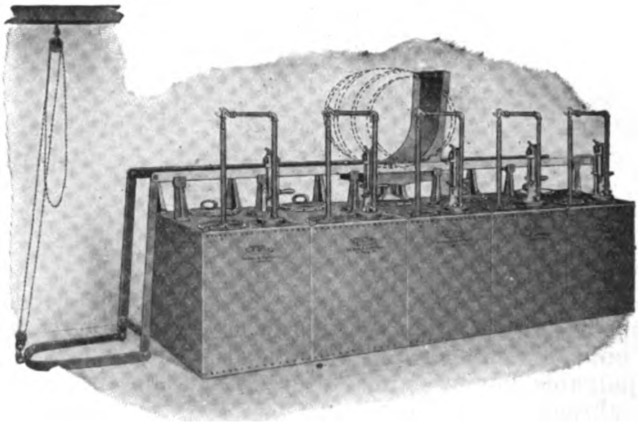
Construction

The Wayne equipment is constructed entirely of metal. The tank is made of soft tank steel, galvanized, closely riveted, and all seams flushed with solder. The openings are reinforced, and heavy angle bracing is riveted on the inside of the tank. All tanks are carefully tested and guaranteed oil tight.

Pumps: Pumps also are constructed entirely of metal. The pump bracket and discharge pipe are very rigid and fastened to the top of the tank by heavy screws. The nozzle is designed to prevent dripping, stopping the flow instantly when pumping ceases. Each pump is equipped with a lock which prevents the operation of the pump by unauthorized persons.

Valves: The valves used in connection with the pump are made of solid brass. Each valve is carefully machined and then hand ground, each being carefully inspected at each step.

Drip Pan: Each tank is provided with a drip pan under the nozzle. This consists of a heavy ring riveted to the top of the tank, in which is hung the galvanized drip pan proper. The drip pan has a ¾″ hole in the center and is covered with a cast iron grate. A cast iron cover, with an extension tube extending to the nozzle, is attached by a hinge. This cover is also provided with a pad lock.



Cut No. 63

Installation

Wayne Tanks are designed as separate and independent units, uniform in height and length, varying only in width. Where a number of oils are required to be kept on hand, the battery is the proper installation. Additional tanks can be added from time to time as desired, or unnecessary tanks may be removed, without disturbing the remainder. The tanks are neat and attractive in appearance, and promote neatness and tidyness among the men.

Equipment

For a battery of tanks it is best to have a barrel track, cradle, hoist and barrel drainer as shown in the illustration. This facilitates refilling the tanks, and saves much labor and expense. One man can easily hoist the barrels and fill the tanks when so equipped.

TANK SIZES

	Height	Width	Length
2 Barrels, 120 gal.	28½″	24″	40″
3 Barrels, 170 gal.	28½″	34″	40″
4 Barrels, 220 gal.	28½″	44″	40″
5 Barrels, 280 gal.	28½″	55″	40″

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VENTILATING SECTION

Treatise

and

Engineering Data

The following manufacturers have catalogue descriptions in this section:

American Blower Co.
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Ilg Electric Ventilating Co.
Jeffrey Mfg. Co.
Johnston, Morehouse & Dickey Co.
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Morse Chain Co.
Robinson Ventilating Co.
Stine, J. C.
Turner, Laurin H. Co.
Vulcan Iron Works.

For additional descriptions of Ventilating Equipment not appearing in this section refer to Index of Products in front of the book.

MINE VENTILATION

By E. N. Zern, E. M.*

The purpose in coursing air currents through a mine is two-fold; first, to sweep away from the working faces and carry to the outside the accumulations of powder smoke and other noxious gases, which would in a short time prove injurious to the health of the workmen; second, to effect the removal of dangerous gases, such as methane, which, if undisturbed, would collect in sufficient quantities to form an explosive mixture with the air. Since all mines are constantly liable to accumulations of noxious gases, and, moreover, since all mines are gaseous, though in greatly varying degree, it follows that mine ventilation is a subject of vital importance, and it may well be suspicioned that the failure to understand the simple principles on which it is based has been the underlying cause of several mine disasters.

Beginning with the early writings of John Buddle, passing to the publication of that truly wonderful book, "A Conversation on Mines Between a Father and His Son", by William Hopton, in 1864, then to the investigations of Atkinson, and on to the more recent times, many treatises on mine ventilation have made their appearance and much valuable information on the subejct has been presented. Unfortunately, with a great many the impression still prevails that ventilation is a subject too difficult to comprehend and that because of the vexatious formulas, mastery of the subject is open to but a few of the "elect". Much has been done to further this impression by examining boards in the various states, which, with a predilection for high-sounding formulas, and in their eagerness to test the memory of the applicant, rather than his common-sense practical knowledge, have side stepped questions of every-day importance. One result of this undue emphasis has been to further the delusion that dependence can be placed on ventilation formulas to furnish reliable answers to all queries raised. In many instances problems given by examining boards do not, and can not, truly represent the conditions in the mine. What, for instance, can cause more confusion in the mind of the student, and prove more misleading, than to unduly emphasize formulas on the natural splitting of air currents, which can hold true only when all splits start from the same point—a condition so rarely satisfied as to be truly a novelty? In the struggle to master formulas, the splendid truths which they contain are frequently lost.

This article will deal with practical mine ventilation, touching on the theoretical only when it assists in a better understanding of the subject. It will be an elementary discussion in which the fundamental formulas will be explained and such basic facts presented as are pertinent to the subject.

Historical

In the primal days of the coal industry little or no attention was given to ventilation. All workings being close to the outcrop, explosive gases were seldom met with. If fire-damp was encountered, the danger of explosion was minimized because there was seldom sufficient circulation of air to form with the methane an explosive mixture. If the fire-damp persisted the simple workings were readily abandoned and fresh ones sought.

The adoption of the steam engine in all industries, about 1770, created an increased demand for coal and made it necessary to sink shafts to the lower measures. Often for want of pure air in these workings candles would not burn and men were unable to work. Relief was attempted by hanging a fire lamp at night in the shaft to clear the workings of foul gases by the next morning. The improvement afforded by this measure, even though meagre, encouraged its continued service, and when this failed to provide sufficient air, it was followed by the larger fire, or furnace. This consisted of a small grate in the side of the upcast shaft in which a fire was irregularly kept by throwing a few lumps of coal occasionally into it. This, in time, gave way to the well constructed furnace located at the bottom of a pit, or more frequently at a compartment of a shaft, which was divided by a wooden partition termed a brattice. Strange to say, the furnace was sometime fixed at the top of the shaft. Of course, most of the heat given off was lost on the surrounding air, and such installations proved so indifferent in their action and power, that they were henceforth placed at the bottom of the shaft.

Other means to provide the necessary air current were the bellows; by hopper construction at the top of the downcast shaft, into which blew the force of the air on the surface; the water fall; the air pump; heated air pipe or cylinder; and the steam jet. The air pump was of primitive construction and capable of drawing about 8,000 cubic feet of air per minute. By the year 1851 many of these, built on Struve's plan, were in operation at Welsh collieries. The steam jet, likewise, gained considerable prominence as a ventilating power and its merits, as compared with furnace ventilation, were much discussed. It consisted of a line of pipes through which live steam was carried to the bottom of the shaft where it was released to heat the air.

The water fall was used at mines where water was abundant. A stream was led to a closed box placed in the shaft and so broken up in its descent that air currents were induced to enter the box and mingle with the water and thus carried to the bottom of the shaft. The accumulation of air produced pressure and forced the air on through the workings. The difficulty lay in getting rid of the water, which was conveniently arranged only when an adit could be used. This system is still found in a few of the metal mines of our western states, drainage tunnels, or adits being relied on to discharge the flow of water.

While both the steam jet and the water fall have passed almost into oblivion, they are sometimes relied on to help out in emergencies or in small operations of shaft sinking. As an instance of the former may be cited an unusual occurence near Audenreid, Pa., in 1907, when nine men lost their lives in old workings through carbon monoxide poisoning.* By means of two streams of water turned down a shaft a sufficient current of air was produced to sweep out the poisonous gas and enable the recovery of the bodies.

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*Head of Mining Department, West Virginia University.

Nasmyth built his first ventilating fan in 1851 wherein was embodied the principle of the centrifugal fan as found today. Improvements on the Nasmyth fan sprung into prominence and because of their superior action as compared to furnaces they quickly won ascendancy as a ventilating medium.

In the original system of ventilation the air current was passed continuously through all the mine-ways, making, in the case of the older mines, a considerable distance traveled. Mention is made of one English mine where the air traveled 40 miles in one current before reaching the surface, and Hopton, almost in despair at the failure of his countrymen to comprehend the virtues of separate air currents, concludes that "if the route extended as far from the downcast through the workings to the upcast, as one end of the river Nile is far away from the other, go it must, if only it can travel." It was not until 1850 that splitting of the air was attempted, the credit for which is due largely to Hopton, who, though beset by skeptics and scoffers, continued to proclaim the greater safety in having the air travel the workings in several splits.

THE WEIGHT OF AIR

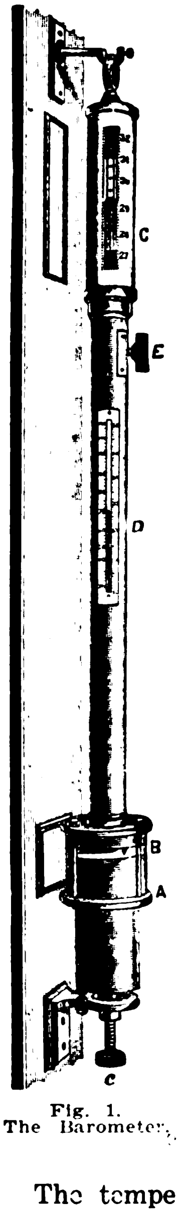

Fig. 1.
The Barometer.

Living as we are at the bottom of an atmospheric ocean, estimated to be about 45 miles deep, we have long since come to accept the truth of the statement that air has weight. If proof were wanted we could find it in every gentle breeze which blows, or in the wind blast, raging with a violence that levels buildings and scatters ruin in its path. Both of these phenomena are due to a difference in the weight of air bodies. It is likewise a matter of every-day observation that warm air rises while the cooler air falls. To this fact is due the burning of a lamp, the heated air rising above the wick and drawing in a continual supply of cooler air from below. The explanation of this is that the air above the flame, being heated, expands and becomes lighter in weight, volume for volume, than the surrounding cool air which rushes into the lamp in an endeavor to restore equilibrium. Another familiar way of demonstrating that air has weight, and therefore pressure, is by its action in forcing water through a suction pipe into a pump chamber from which the air has previously been exhausted.

Air, therefore, though comparatively light, is positively heavy, having a weight of its own. A square inch of it measured from the surface of the earth at sea level to the top of the atmosphere, is no less than 14.7 pounds in weight. The instrument used to record the weight, or pressure of the atmosphere, is known as the barometer, and is shown in Fig. 1. This consists of a glass tube about 34 inches long, filled with mercury and inverted with its lower end constantly below the surface of mercury in a cistern. The pressure of the air having access to the mercury in the cistern raises the mercury in the tube to a point where a balance between the two obtains. By means of a scale, C, graduated in inches the height of the mercury column is read, which thereby indicates the pressure of the air. In reading the barometer the surface of the mercury in the cistern must be brought to the fixed zero. This is done by turning the screw, c, until the mercury just touches the point of a pin projecting downward from the frame of the instrument, which point is the zero of the scale.

The average height of the mercury column at sea level is 29.925 and if it have a cross section of one square inch its weight will be 14.696 pounds. Since there is perfect equilibrium between the mercury column and the atmospheric column it follows that the weight of the mercury, 14.696 pounds, is the measure of air pressure on one square inch of surface. For ordinary computations the height of the mercury at sea level may be taken as 30 inches and its weight 14.7 pounds. Since the pressure of air is due to its weight, points of high elevation will show a lower barometer reading than 30 inches, while points below sea level will show a higher reading.

The weight of dry air, being dependent upon altitude and temperature, may be determined at any altitude and temperature by means of the following formula:

$$w = \frac{1.3273 \times B}{460 + t} \qquad \text{(a)}$$

where w=the weight of one cubic foot of air
B=the barometer reading in inches of mercury
t=the temperature of the air in Fahrenheit degrees

NATURAL MINE VENTILATION

The temperature at any point on the earth's surface fluctuates considerably throughout the day and shows a greater variation with the seasonal changes. Inside the mine, however, conditions are such as tend to hold the temperature fairly constant day in and out, throughout the year, the variation at places well within not much exceeding five degrees. In the winter period the temperature of the incoming air is raised by rubbing against the top and sides, by the burning of lamps, breathing of men and animals, oxidation of coal and wood, natural heat of the strata, etc., all of which add their quota of heat to the cold air. In the summer time, the strata being colder than the incoming air, the latter is chilled and rapidly cooled until approximately the same temperature is reached as prevailed in the winter period.

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*Mines and Minerals, Vol. 28, p. 21.

Assuming the inside temperature to be 60 deg. F. (which is probably quite close to the average the year around in the Eastern states) and an outside temperature of, say, either 20 deg. F. or 90 deg. F., it follows that owing to this difference in temperature there must be a difference in the weight of like volumes of internal and external air, and hence, with respect to each other, they must be in a condition of unstable equilibrium. Let us investigate this by assuming the outside temperature to be that first mentioned, that is 20 deg. F., the average temperature in the air shaft, see Fig. 2, being 60 deg. F. and the barometer reading 30 inches. The problem is to determine the direction in which the air will flow in the mine.

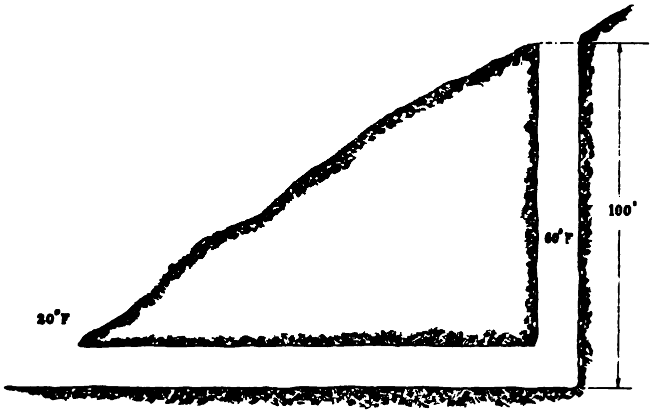

Fig. 2.

The weight of the air at the pit mouth will be found by formula (a) to be,

$w=\frac{1.3273\times30}{460+20}=.083$ lbs. per cubic foot of external air.

The weight of air in the shaft will be,

$w=\frac{1.3273\times30}{460+60}=.077$ lbs. per cubic foot of internal air.

Since the external air is heavier the excess pressure will force the air in toward the shaft, i. e., the shaft will be an upcast.

If we now assume the outside temperature to be 90 deg. F., the inside temperature and barometric pressure remaining the same as before, we then have for the weight of air at the pit mouth,

$w=\frac{1.3273\times30}{460+90}=.072$ lbs. per cubic foot of external air.

Since the external air is now lighter than the mine air, the pressure of the air in the shaft will force a current toward the pit mouth, i. e., ventilation is now reversed and the shaft has became a downcast.

The assumptions made in this case serve well to illustrate the changeableness of natural ventilation. In the transition period between extremes of heat and cold, and frequently throughout one or more periods in each summer day, the outside and inside air will be at the same temperature. The weights of air being the same, the pressures will be balanced and flow of air will cease. Natural ventilation is at its greatest usefulness when the weather is either extremely hot or cold. While it is the most economical system that can be used from the power standpoint, it is undependable since subject to fluctuations which can not be controlled.

FURNACE VENTILATION

Furnace ventilation is based on precisely the same principle as natural ventilation, the difference in the systems being that in furnace ventilation, heat is applied artificially to raise the temperature of the column of air in the upcast shaft to such a point that it will always be above the temperature of the external air. Furnaces are placed close to or at the bottom of the air shaft.

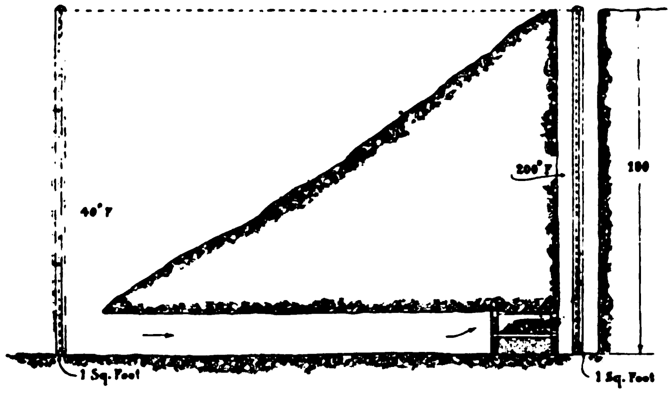

Fig. 3.

See Fig. 3. The heat of the fire causes the air in the shaft to expand and become less dense, whereupon the heavier air from the outside is pushed along to take its place. The higher the temperature of the heated air, the greater will be the quantity that will pass over the furnace. The direction of the air current is always from the mine opening toward the air shaft.

Let us assume a furnace placed at the bottom of a shaft 100 feet in depth, as in Fig. 3. The average temperature of the upcast air is 200 deg. F., while that of the outside air is 40 deg. F. Barometer reading is 30 inches. Find the difference in weight of a cubic foot of air in the upcast and outside respectively.

$w=\frac{1.3273\times30}{460+200}=.060$ lbs. per cubic foot of upcast air.

$w=\frac{1.3273\times30}{460+40}=.080$ lbs. per cubic foot of outside air.

$.080-.060=.02$ lbs., the excess weight per cubic foot of outside air.

If we construct, both in and out of the mine, an imaginary column of air one square foot in cross section whose height shall be equal to the depth of the shaft, or 100 feet, each column will then contain 100 cubic feet of air.

The weight of column in upcast shaft is $100\times.06=6$ lb.

The weight of column on outside is $100\times.08=8$ lbs.

Since the difference of weight of columns, or two pounds, is based on a square foot of cross section, this then becomes the unit ventilating pressure of the system. The outside column is the heavier and therefore produces the circulation of the air. Being heavier, a fractional part of its length will be sufficient to balance the entire length of lighter column in the upcast shaft. The remaining part must then be producing the ventilating pressure and is known as the motive column. It is upon the height of this motive column that the efficiency of the furnace will greatly depend, and it follows that the greater the depth of upcast shaft, the greater will be the motive column and the quantity of air passing. In the case of shallow shafts a measure of assistance may be given by adding a wood stack to the top. This, in effect, is the same as adding to the depth of the shaft, or, in other words, increasing the motive column. Thus, if a stack 40 feet in height was placed over the upcast shaft and the same average temperature maintained as stated in the problem, the ventilating pressure would be increased from 2 pounds to 2.8 pounds.

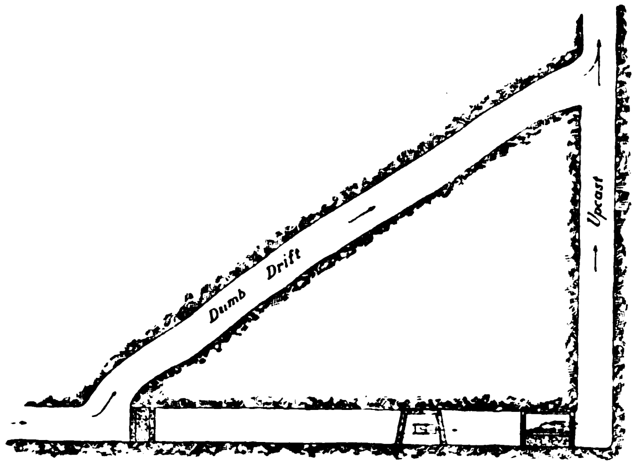

Fig. 4.

Where furnaces are installed every precaution should be taken to guard against igniting the surrounding coal. A brick wall offers good protection, sand being placed in the space between the wall and the coal. Air passages at the side serve to protect the coal from excess heat.

In gaseous mines there would be grave danger in passing the return air current, containing methane, over the fire. In this case a dumb drift, as shown in Fig. 4, could be driven, starting at a point beyond the furnace and meeting the air shaft at a distance where the temperature of the column is sufficiently reduced to make impossible the ignition of the gas. The air necessary for the combustion of the coal in the furnace is derived by taking a small split of pure air directly from the intake.

The day of the furnace has passed. They were largely in use fifty years ago and in the deeper shafts gave good results. Abel tells us of underground furnaces capable of circulating volumes from 200,000 to 400,000 cubic feet of air per minute.[*] At the present time their usefulness is restricted to the preliminary stages of mining. No elaborate constructions are attempted, and more frequently a fire basket, such as shown in Fig. 5, is relied upon to produce the small volume of air needed. When the mine is once developed, with many branch entries and rooms for the air to course through, the furnace is inadequate to supply the needed air. Relief may be had by increasing the area of the grate so that more coal may be burned, and hence a higher degree of heat given to the ascending air, but a point is soon reached where the cost of coal consumed, plus the labor cost in getting fuel to the furnace, tending the fire, removing ashes, repairs, etc., exceeds the cost of fan ventilation. Added to these considerations are the unsafety of the furnace and its probable destruction and inaccessibility in case of an explosion.

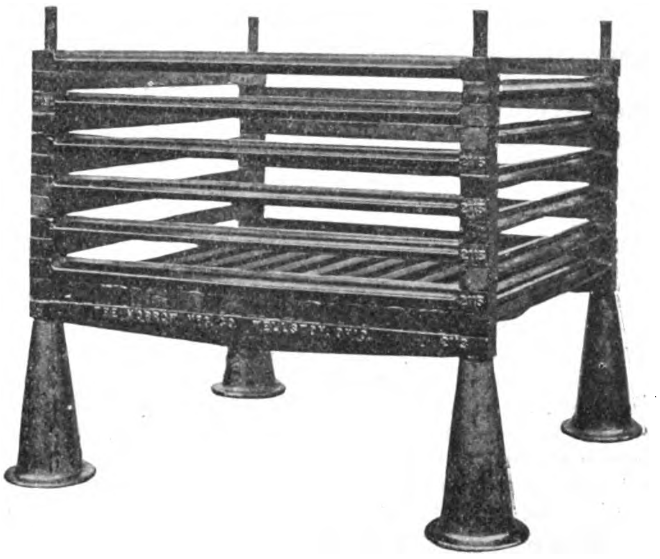

Fig. 5.

THE FUNDAMENTAL FORMULAS ON WHICH MINE VENTILATION IS BASED

$q=av$ (1)
$R=P=pa$ (2)
$R=klov^2$ (3)
$p=5.2\,i$ (4)
$u=pav$ (5)
$HP=\frac{u}{33000}$ (6)

These are the six fundamental formulas in mine ventilation. They should be thoroughly understood and so effectively memorized as to be constantly available for use. Each formula will be explained and its application made clear.

$$q=av$$

q=number of cubic feet of air per minute
a=area of airway in square feet
v=velocity of air current in feet per minute

This is the formula most used in mine ventilation and is relied upon by the mine official in figuring the quantity of air circulating in an air passage, as required by the mining laws.

The method of finding the area of an airway, a, will depend upon its shape. There are four probable forms, the circle being included in these since this is the resulting section where a machine, such as the Stanley heading machine, is used. The method of finding the area of each form is indicated in figure 6:

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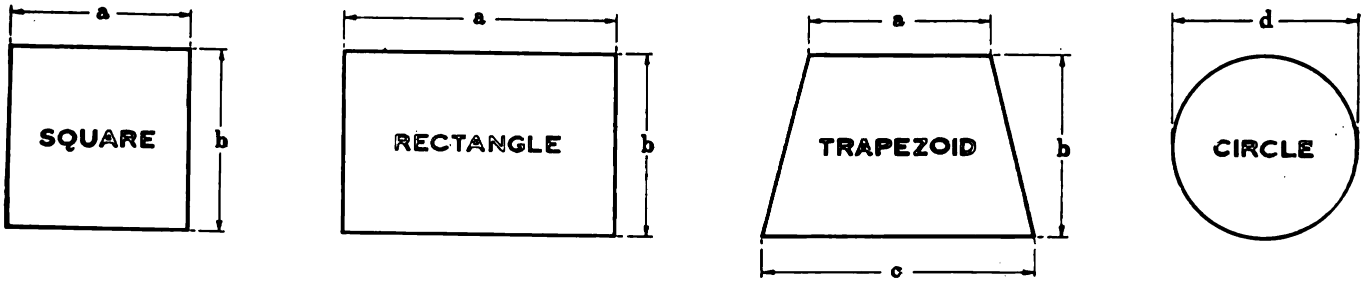
[*] Mining Accidents and Their Prevention.

Any of the first three shown, the square, the rectangle, or the trapezoid, are commonly encountered in mines. Where the seam is thick, the square, or nearly equal sided rectangle, is common; in the thin seams the rectangular shape prevails. The trapezoid, as such, is seldom the result of design, though such a shape may occur where a heavy roof pressure is thrown on the entry and spalls off the coal. The fact is that the sectional area of an airway is not regular in outline but is continually changing throughout its entire length, due to irregularities in undercutting and blasting, weakness of roof and bottom, breaking off of coal along the sides, etc. Thus it happens that in all mines a variety of shapes are encountered.



Area=$a \times b$ Area=$a \times b$ Area=$\frac{a+c}{2} \times b$ Area=$.7854d^2$

Fig. 6—Forms of Airways and Their Areas.

It is a requirement of most mining states that the quantity of air passing into the mine be determined at regular intervals and that an official record be made of the volume found. This relates not only to the main current but also to each split of air made off the main current.

Measurements of the main current are made in both the intake and return air courses at such points where the entire body of the air is passing. One such point will be close to the fan, or near the bottom of the air shaft, in the case of shaft mines, while the other will be a short distance in from the pit mouth, or bottom of hoisting shaft. Since these points are easily available and will be used for the determination of quantity throughout the life of the mine, their selection should be carefully made.

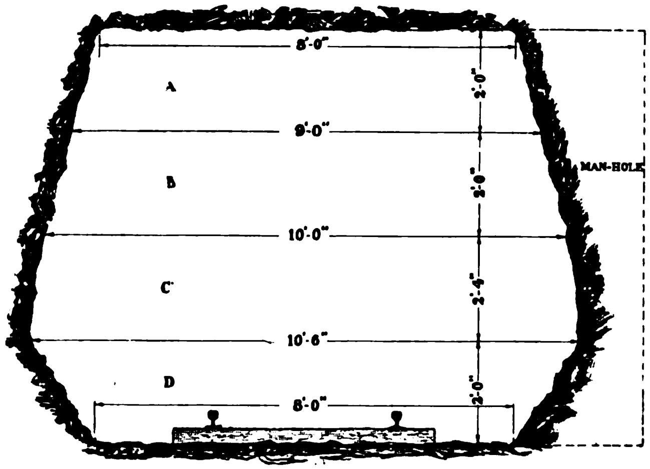


Fig. 7—Determining the Area of An Irregular Section.

First, a length of entry should be sought that is regular in cross section, with a minimum of timbering, roof cavities, or other obstacles to an uninterrupted passage of the air. Second, the section of entry should be straight so that there will be no eddies, or cross currents of air, to interfere with the correctness of the anemometer reading. Having such a length of entry available a good plan is to whitewash the sides and top of a strip about a yard in length and let this be the permanent location for the taking of all subsequent readings.

The height of an entry at a given point may be constant, while the width varies from top to bottom and is impossible to determine with a single measurement. Approximately correct results may be had by taking the average of a number of measurements, but if greater precision is thought necessary, the total area of the entry can be determined by dividing the cross section into a number of trapezoidal or rectangular sections as shown in Fig. 7, and computing the area of each.

The area having been found, the velocity, v, is arrived at by the use of the anemometer. This is a device consisting of a number of vanes placed obliquely around an axis. The force of the air against the vanes turns the axis, which motion is communicated by suitable mechanism to dials which register the velocity of the air in feet per minute. The manner of taking the reading is for the observer to stand facing the side of the entry and holding the anemometer in a fixed position at arm's length. Since the frictional resistance along the sides, top, and bottom of entry is greatest, and therefore, the current of air is slower than at the center, a more reliable reading is obtained by moving the anemometer up and down and across the entry. A reading can thus be taken for say three minutes and the total obtained divided by three to strike the average velocity for one minute.

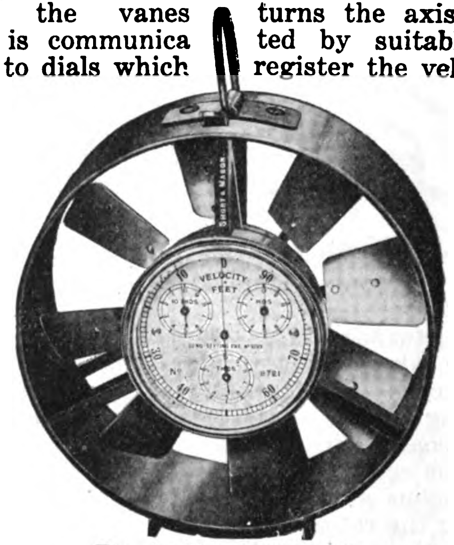


Fig. 8—The Anemometer.

Since the body of the observer is in the current of air and therefore obstructs the passage, a still greater degree of precision can be obtained if the observer stands in a man-hole cut in the entry side as shown by the dotted lines in Fig. 7. The position of the anemometer can be varied through the reading by attaching it to a rod, thus permitting all parts of the entry, far and near, to be reached. The levers are worked by means of a cord.

It is seldom that refinements such as these are practiced, as for ordinary usage approximately correct results are deemed sufficient. The anemometer, itself, will give a correct reading at a certain speed only, it having been found that, in general, readings are too low up to a velocity of around 500 feet per minute, and too high above this. Charts are furnished by the makers showing the correction to be made at various speeds.

There are a number of other ways in which the air may be measured. Pitot tubes, or special shaped nozzles, orifice discs, and all their modifications may be used with good results.

A newer method based upon an old principle, and one that overcomes the limitations and inaccuracies of the anemometer method, has been successfully tried out by a number of leading coal companies. The principle used is that of the well-known Pitot tube. The air velocity causes a certain differential pressure, which is definitely related to it.

$$h = KV^2$$

Where h = differential pressure
V = air velocity
K = a constant depending on pressure, temperature, etc.

By providing a suitable device for measuring h, we have a direct and accurate means of measuring the velocity, v. This becomes extremely simple if the measuring device be placed within the mine. In this case it is necessary to measure but one pressure, that in the tube facing the air flow, since the other pressure is everywhere present and is automatically measured. Hence by holding a tube, with the end bent as shown in Fig. 9, to the air flow, and connecting the other end to a suitable measuring device, a means is obtained for determining the velocity which is simple, accurate and quick. This principle is used in the Velocity Indicator, shown in the figure.

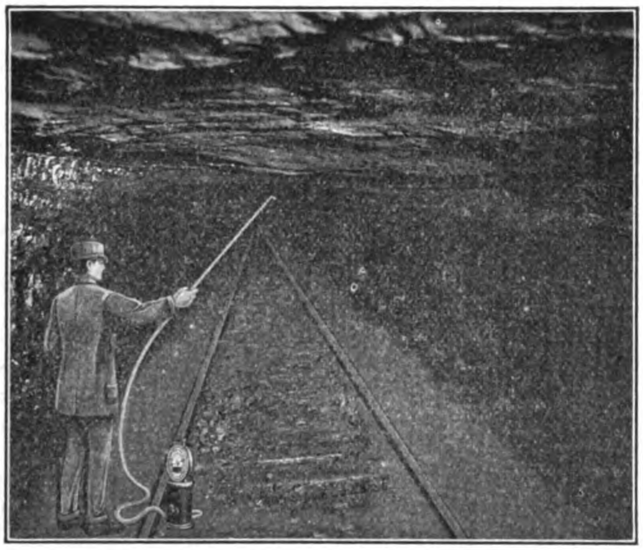


Fig. 9.

A short piece of rubber hose connects the straight end of the tube to the nipple of the instrument. The operator then stands well on the side and simply points the bent end of the tube to the air flow. The velocity will instantly be indicated on the dial of the instrument, the reading being in feet per minute direct. By simply moving the end of the tube around to different points in the cross section of the channel, the true average velocity can quickly be found. All points are easily reached with the Velocity Indicator tube.

The construction of the Velocity Indicator is based upon the hydrostatic principle. This is simply a float balanced in water in such a way that the air velocity or impact pressure, which is transmitted through the tube to the underside of the float, causes the float to rise. This float motion is used to move the pointer over the dial, which is graduated to read the velocity directly in feet per minute.

No air passes through the instrument. The impact pressure due to the velocity of the air is simply transmitted through the tube to the float. As the float rises with an increase of pressure, due to an increase in velocity, it moves the pointer over the dial by means of a very simple arrangement.

Irrespective of the type of instrument used, velocity readings on all splits are taken in the last cross-cut through which the air passes into the return air course. The wisdom of this provision of the law will be apparent, since any leakages of air from the intake to the return side of the circuit will not be recorded. In order to keep above the minimum requirement an incentive is thus provided for the building of tight stoppings.

The minimum quantity of air required in mines is fixed by the laws of the various states which base the amount on, first, the number of men and animals within the mine, and second, whether or not the mine is gaseous.* In addition to this minimum amount it is wisely stipulated that there may be required by the mine inspector as much more as he deems necessary. It is common custom in all well regulated mines to far exceed the minimum requirements of the law. In spite of this, however, it must be admitted that the proper quantity of air in a mine, or section of the mine, is still largely a matter of guesswork.

The purpose of ventilation is recognized to be the supplying of a pure and safe atmosphere within the mine. This is accomplished as will be noted elsewhere, by means of stoppings, overcasts, doors, and brattices which conduct or deflect the air into its proper courses. Once an amount of air sufficient to accomplish both these purposes is supplied any excess amount is circulated at the expense of economy, and perhaps, safety—at the expense of economy because the volume of air is badly proportioned to the work to be done; at the expense of safety because in the cold months the stream of air, being in excess, may absorb additional moisture from the dust, rendering it more dry and harmful. A further example of ineffectual and uneconomical ventilation is found in the passing of over-abundant air currents through entries, with little or no attempt to compel the air to sweep the faces of the room. The smoke and noxious gases collecting at the dead end of the room are expected to move out into the passing air current by diffusion. In all such cases it will be found that a current of less volume, deflected to the rooms by curtains and led to the face by brattices will furnish far better results, both from the standpoint of health and safety, at a decreased cost of power.

In gaseous mines the second object—to dilute and remove explosive gases—is the principal one. The mining laws of all states require an additional amount of air per man and beast if the mine generates gases in dangerous quantities, but this additional allowance provides no guarantee that the return is non-explosive—a matter of decided importance in the operation of a gaseous mine. If the methane is present in quantities as large as 1½ per cent. and over, it may be found with the aid of the oil safety lamp, but such a volume of methane is now regarded as far too high to be considered safe in an atmosphere containing fine dust in suspension and sweeping past myriads of dust particles lodged on sides, roof and timbers. Some device which will reliably indicate lesser percentages of methane is the need here.

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*See Miners' Circular 16, Bureau of Mines.

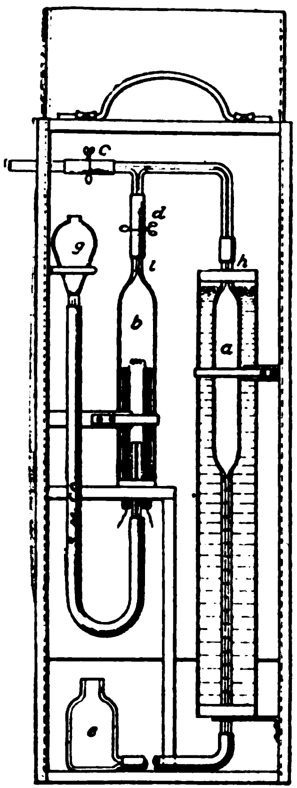

Fig. 10

A method coming more and more into use at mines is to collect from the main current and each split, samples of air in tin cannisters, or bottles, at regular intervals of one or two weeks and to have these analyzed, either for methane alone, or for both methane and carbon dioxide. The Consolidation Coal Company of West Virginia uses the Hesse titration method for the determination of both gases.* The Burrell apparatus, shown in Fig. 10, is much used for this purpose. It is an inexpensive device and so simple in operation that the details of its use can be readily mastered.† It is accurate to within 1/10 of 1 per cent of methane.

The interval between the taking of samples will depend largely upon the gaseous conditions encountered. In some of the European mines the air from each split is analyzed daily, and if the percentage of gas runs over 0.50% the quantity of air is increased or some other means taken to reduce it. The principal value of the information derived by analyses can be shown by supposing a certain split, having 12,000 cubic feet of air per minute, to show by analysis .85% of methane in the return air current, while a neighboring split having 28,000 cubic feet show .15% of methane. By means of a regulator a sufficient volume of air may be taken from the latter split and added to the former, so that the amount of methane in each will be about 1/3 of 1 per cent. In this way the safety of the mine is increased and the ventilation in each split is proportioned to the actual needs.

$$R = P = pa$$

R=total entry resistance

P=total ventilating pressure.

p=the unit of ventilating pressure, or the pressure in pounds per square foot of sectional area.

a=the area of cross section in square feet.

In passing a current of electricity through a wire, a stream of water through a pipe, or a quantity of air through a mine passage, a certain amount of opposition or frictional resistance is encountered which varies with the amount passing.

When water flows through a pipe the resistance is overcome and flow effected due to the difference between the water levels at the end of the pipe, or the "head" of water. In the case of air, flow in an entry results when the resistance is overcome by the total pressure on the air, thus, R=P.

The total pressure, P, at any cross section of the airway is plainly equal to the pressure, p, on each square foot times the number of square feet in the cross sectional area, thus P=pa.

This formula is important because it makes clear that the ventilating pressure will vary directly with the resistance offered to the passage of air through the mine, that is, the more resistance, the more pressure will be required. Since it is only by the expenditure of power that pressure is developed, it follows that all unnecessary obstacles to the passage of air are reflected in the cost of power.

$$R = k\,l\,o\,v^2$$

R=total entry resistance.

k=coefficient of friction, i. e., the resistance, stated in pounds, offered by a square foot of rubbing surface to the passage of a current of air having a velocity of one foot per minute.

l=the length of entries which the current of air travels.

o=the perimeter of the airway, found by adding together the lengths of the sides bounding the section.

v=velocity of air current in feet per minute.

Of all the formulas used in mine ventilation, this one is, by all odds, the most important, and a clear understanding of its meaning is essential to the mine manager who would attain the greatest economy and efficiency in the coursing of the air. No other formula has within it such a fund of information. It bears the same importance to the mine official that Ohm's law does to the student of electricity, and he who so values it and understands well its meaning will be found conducting the air on principles which are sound.

Each factor which enters into the formula will be discussed separately.

The Coefficient of Friction, k.

The reason why powerful engines are required to drive the fan is because the air in passing through the airways meets so much resistance from the sides, roof and floor of the entry. The moving air current is continually rubbing against surfaces, some smooth, as a body of water in a local depression, some rough, as a section of entry littered with falls from the roof, against timbers, doors, regulators, stoppings, overcasts, mine cars, etc. Turning sharp curves or making sudden contractions and expansions, due to enlargings or restrictions in the air course, are in effect similar to meeting obstructions. In every instance resistance is offered to the movement of the air. However, since the major portion is offered by the rubbing surface of the entry, the coefficient of friction is customarily defined as the resistance offered by a unit of rubbing surface, or one square foot, to a current of air—to which is added "having a velocity of one foot per minute", for we shall see further on that velocity plays a very important part in the resistance offered to air currents.

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*Proceedings West Virginia Coal Mining Institute, 1909.

†See Technical Paper 14, Bureau of Mines.

The value of this coefficient has been determined by various investigators, and since no two mines are quite the same, there is, as might be expected, a considerable variance in result. The following table is taken from the Coal Miners' Pocketbook:

Table of Various Coefficients of Friction of Air in Mines.

J. J. Atkinson's Treatise	.0000000217
A. Devillez in Ventilation des Mines	
Forchies	.00000008211
Crachet-Picquery	.00000008928
Grand Baisson	.00000008611
Used in Ventilation des Mines	.00000009511
Arched Tunnels	.00000002113
Along a Working Face of Coal	.00000014266
G. G. Andre, Atmosphere of Coal Mines	.00000022424
Peclet, Cheminee (Devillez, p. 112)	00000003697
D. K. Clark	.00000002172
According to Goupilliere's Cours d' Exploitation des Mines	
D'Aubuisson	.00000001955
Navier	.00000001872
W. Fairley	.00000001
J. Stanley James	.00000000929
D. Murgue	.00000008242

Thomas W. Fitch, Jr., gives the following values of k:*

For galvanized steel piping	.0000000024
For air passages which are concreted, wood lined, or of exceptional smoothness, and untimbered, straight, regular and free from obstructions	.0000000035
For air passages which are untimbered, fairly smooth, straight, unobstructed and regular in size	.0000000073
For air passages which are untimbered and moderately crooked, irregular, obstructed and rough	.0000000105
For air passages which are timbered, but otherwise fairly smooth, straight, unobstructed and regular in size	.0000000146
For air passages which are timbered and moderately crooked, irregular, obstructed and rough	.0000000182
For air passages which are timbered, and very crooked, irregular and rough	0000000219

The highest of these values, .00000022424, as given by Andre, is about twelve times the lowest, .00000001872, as given by Navier. A computation for entry resistance, using each formula in turn, would show a like variance in results. It is plain, therefore, that before accurate results can be expected from a mathematical computation of resistance, the value of k for that particular mine must be known.

The value of k, .0000000217, as given by Atkinson, is the one best known and most used, though in all probability it is far too high to fairly represent the average mine. Long usage, it seems, has given it acceptance, to such an extent that there has been little disposition on the part of investigators to determine the real value for a mine, or a group of mines operating under like conditions. In justification of the use of an inordinately high coefficient it is urged that it is preferable to using a coefficient too low, and this is unquestionably true. Superior to either, however, is the rightful value. A simple method of arriving at this will be found on page 14.

The factors which create a high value for the coefficient of friction in the mine are:

1. Entries littered with falls of top rock, or obstructed with old mine cars, etc.
2. Rough and irregular sides, top or bottom, due frequently to carelessness in undercutting and blasting.
3. Useless timbering.
4. Overcasts having no filling of rock behind the side walls to provide an easement for the air.
5. Sharp turns in the air course.
6. Sudden contractions and expansions.

Anything which creates undue resistance should be avoided, for the higher the coefficient of friction the greater will be the power required to move the air.

Length of Entry, l

The formula, $R = klov^2$, amongst other things, states clearly that the resistance encountered by the air current varies directly as the length of the passages traveled, i. e., the more length, more resistance; less length, less resistance.

In the development of a mine, entries are driven with the utmost dispatch to all points of the property and their steadily increasing length introduces a factor which is constantly adding to the resistance. This, however, is unavoidable, though sometimes much can be done to shorten the travel of the air, as will be cited later.

In practice, a great difficulty arises in determining the distance traveled by an air current in sections where rooms are being worked. If all ventilation were done in the entries this could be easily determined by scaling off the distance on the mine map. When measures are taken, as should be done, to deflect most of the air into the rooms, it introduces an element of uncertainty as to the course, or courses, the current is taking. In longwall workings, finding the total length of travel is greatly simplified since the air sweeps across one long face. Owing to this difficulty in determining the length of travel in room sections, problems in mine ventilation restrict the air to coursing in entries.

Since, in the development of mines, the length of travel is being daily increased, and granted that to have effective ventilation, air should be largely deflected from the entries into the rooms, thereby again increasing the travel, the question may arise what can be done to decrease l in the formula, and thereby effect a corresponding decrease in the total resistance, R? This question frequently arises in an acute form in the case of old mines where the length of air travel has become excessive. The only solution may be the installation of a more powerful ventilating unit, though it is possible that one or more of the following suggestions may provide relief:

1. If a drift mine, openings may be made to the outcrop, wherever convenient, and air brought in, or forced out, at these points, thus often eliminating thousands of feet of travel. Shallow shafts will answer the same purpose when outcrop openings can not be made.
2. In old mines where all the coal near the openings has been removed, leaving the workings at the center or near the remoter boundaries of the property, the fan may be removed from its original position and set at the top of an air shaft, sunk through shallow cover to intercept the workings.
3. In some instances, notably in the panel system, where sections have been fully developed ahead of the workings and are non-gaseous, the travel of the air may be shortened by driving a few rooms on each entry to intercept the air course of the adjoining entry.

The Perimeter, o

From the single standpoint of reducing resistance, the perimeter should be kept small, but other considerations, such as height of seam, condition of roof, haulage, etc., will dictate the size of entry. The perimeter of airways in any mine working but one seam is therefore a more or less fixed quantity and no modification will be made solely to accommodate the ventilation requirements.

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*Proceedings West Virginia Coal Mining Institute, 1910.

It is interesting to note here that the perimeter of an airway having a stated cross section will vary with the form of entry. For example, each of the following forms have an area of 64 square feet though the perimeter shows a considerable variation.

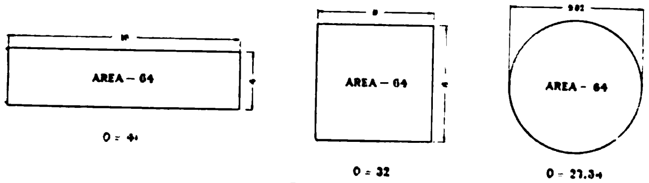

Fig. 11.

It will be noted that the square-shaped entry has 40—32=8 feet, or 20% less perimeter than the rectangular shape. In like manner the circular form has 32—27.34=4.66 feet, or 14.6% less perimeter than the square shape, and since these percentages would be directly reflected in the reduction of the entry resistance, it follows that the circular, and next to it the square-shaped entry would always be chosen where it not for other determining factors. The fact of this difference, however, is important, as it shows clearly that in mining the thinner seams such as the Beckley or Sewall of West Virginia, with the rectangular entry, there is a natural disadvantage, with respect to entry resistance, as compared to the Pittsburgh seam, where the square-shaped entry may be attained or closely approximated.

The Velocity, v^2

The concluding and most important meaning of the formula is that the resistance offered to a current of air varies as the square of the velocity with which it moves. That this is true will be clear if we consider the resistance offered to a current in a passage-way moving at a velocity of 100 feet per minute. The resistance met is due principally to the particles of air striking the rough sides of the entry. In striking obstructions, not only is the motion of the particle completely stopped, but there is a rebound which requires an expenditure of energy to again set it on its way. Let us represent the measure of such a resistance by the numeral 5. If we now double the velocity, thus having the air travel at the rate of 200 feet per minute, every air particle will meet with double the former resistance due to covering twice the distance in the same period of time. This makes the resistance $2 \times 5 = 10$. Moreover, since the velocity is doubled, every particle will hit obstructions with twice the original force, hence the rebound will be twice as great and twice the energy will be required to again set the particle in motion. This causes an additional resistance of $2 \times 5 = 10$, which added to that already derived, makes a total of 20. Since 20 is the product of 5×2^2, it proves the statement that the resistance varies as the square of the velocity. The influence of velocity on entry resistance, therefore, is much greater than any of the other factors, such as length or perimeter, which are of the first power only in the formula.

It is so arranged in mines that the air coming from the fan is led directly through the fan drift, thence to the air shaft, and thence to the entry or entries from which splits are to be taken to the various parts of the mine as needed. The total quantity of air in circulation being large, a high velocity results and persists in the single air course until by reason of splits to the working sections, sufficient reductions in quantity are made to lower the velocity in the air course, but until these splits are made the resistance produced is high, and hence the power required large.

Methods of reducing the velocity without the sacrifice of volume are:

1. Have an air course of varying cross section, the largest area being at the point of beginning (bottom of air shaft or at point of outcrop) and decreasing in size as splits are taken off, reaching normal size at the point of last split. Any enlargement in the area of the entry would effect a reduction of velocity in accordance with the formula, $q = av$, but since such enlargement would necessarily be made by increasing the width, it follows that the practicability of the plan is limited by the strength of the roof. The plan is furtherfore not attractive for the reason that a sufficient decrease in the velocity is not attainable.

2. Bring in quantities of air from outcrop openings or shallow shafts. The advisability of doing this has already been referred to as a means to decreasing the factor, l. It has a further beneficial effect in lessening the quantity of air traveling either to or from the principal mine openings and hence reduces the velocity accordingly.

3. Drive two or more intakes and the same number of return air courses (multiple-entry system). The air will divide amongst these, thus reducing the quantity in any one entry with a corresponding reduction in the velocity. If a large quantity of air, say 200,000 cubic feet per minute, is coursed through an entry 8 ft. x 10 ft. the high velocity of $200{,}000 \div 80 = 2500$ feet per minute will be the result. If now instead of a double entry system, the intake of which is to carry all of this air to the workings, there is employed the four entry system, two of which are intakes, the air will divide and 100,000 cubic feet pass into each airway. The resulting velocity will be $100{,}000 \div 80 = 1250$ feet per minute. Since the velocity with the 4 entry system is ½ that of the 2 entry system, the resistance due to velocity is decreased $(\frac{1}{2})^2 = \frac{1}{4}$.

It will be seen, however, by comparing the results obtained in the circulation of a given quantity of air in the two-entry, four-entry, six-entry and eight-entry systems, as shown in Fig. 12, that the four-entry system has a resistance of ½ that of the two-entry, instead of ¼. This, it will be found, is because while a reduction in resistance to ¼ was really effected by the decrease of velocity, to attain this it was necessary to double the factor, l, the length of entry traveled by the air, so that the net reduction effected is $\frac{1}{4} \times 2 = \frac{1}{2}$. The following is a comparison of the different systems:

A four-entry system reduces entry resistance ½ as compared with the two-entry system.

A six-entry system reduces entry resistance 2/3 as compared with the two-entry system.

An eight-entry system reduces entry resistance ¾ as compared with two-entry system.

In a study of the multiple-entry system care must be taken to avoid the idea that a four-entry system, for instance, will reduce the **total mine resistance** by ½. Whatever reduction is effected is only in the entries, the resistance met by the air in passing through the room sections obviously remaining the same, no matter through how many entries the air is delivered. In a mine of fair size, however, the reduction effected in the entries is generally sufficient to make profitable the multiple-entry system because it is here that the air will travel at its greatest velocity. This statement is particularly true in the case of shaft mines, where other means of reducing the velocity, such as bringing in air from outcrop openings, are not possible. Balanced against the saving in power would be the cost of driving and maintaining the additional entries.

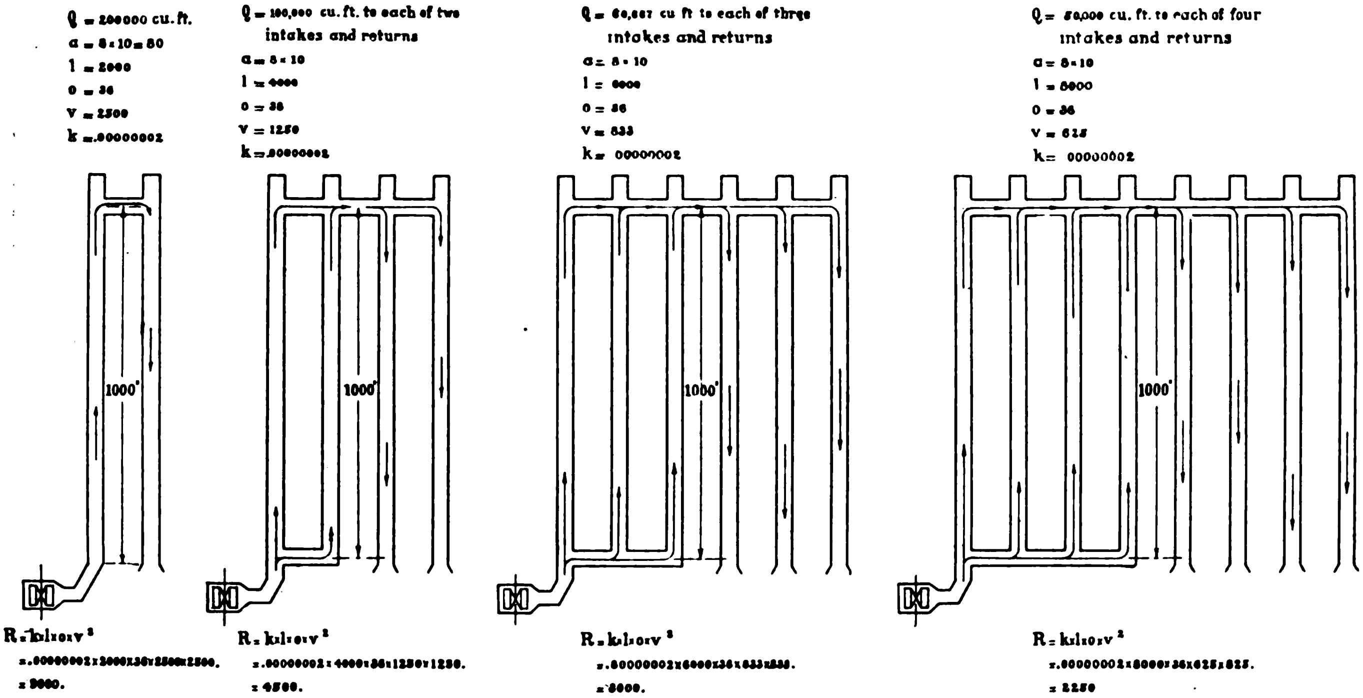
Q = 200000 cu. ft.
a = 8 x 10 = 80
l = 2000
o = 36
v = 2500
k = .00000002
Q = 100,000 cu. ft. to each of two intakes and returns
a = 8 x 10
l = 4000
o = 36
v = 1250
k = .00000002
Q = 66,667 cu ft to each of three intakes and returns
a = 8 x 10
l = 6000
o = 36
v = 833
k = 00000002
Q = 50,000 cu. ft. to each of four intakes and returns
a = 8 x 10
l = 8000
o = 36
v = 625
k = 00000002
1000'
1000'
1000'
1000'
R = klov²
= .00000002 x 2000 x 36 x 2500 x 2500.
= 9000.
R = klov²
= .00000002 x 4000 x 36 x 1250 x 1250.
= 4500.
R = klov²
= .00000002 x 6000 x 36 x 833 x 833.
= 3000.
R = klov²
= .00000002 x 8000 x 36 x 625 x 625.
= 2250

Fig. 12.

4. Split the air into separate currents rather than have it as one continuous body. An effective method of reducing velocity is to lead off separate currents of air, or splits, from the main intake air courses. The ideal manner of accomplishing this would be to have all splits start directly at the bottom of the intake air shaft and to have them rejoined directly at the bottom of the return air shaft. In this way an excessively high velocity would be encountered only in the shafts. An arrangement such as this is closely approximated in longwall workings.

In the room and pillar method of working, the various splits of air do not start from a common point but rather at widely separated distances along the main intake entry. The reduction of velocity in the main body is therefore gradual, and while each decrement assists in lowering the entry resistance, the same high degree of benefit can not obtain as if it were possible to have all the splits proceeding from the same point.

Along with the advantages of lessened resistance should be mentioned that of the better quality of air supplied the workmen when the air is split. The continuous system of coursing the air, whereby it is used first on one side of the mine, there becoming saturated with powder smoke and the various foully laden, into the still remoter sections and finally to the opposite side of the mine, is unfair to the workmen in the latter sections, both from the viewpoint of health and economic production. One of the essential requirements for efficiency in work is an abundance of pure air. Stinting in this regard penalizes not only the miner but also the operator, whose financial returns are dependent upon the productive efforts of the workmen. The fact that men will do better work and more of it in good wholesome air, as compared with air contaminated with the fumes of the mine is everywhere accepted and needs no further elaboration. It is surprising, however, to note the frequency with which this principle is ignored.

The mining laws of each state prescribe the number of men permitted to each continuous current of air, that of Pennsylvania, for instance, allowing seventy persons to a split, though at the discretion of the mine inspector this may be increased to ninety. (A considerable portion of the discussion on splitting will be found under the subject of Overcasts and should be referred to at this point.)

$$p=5.2\ i$$

p=ventilating pressure in pounds per square foot.

i=water gage reading in inches.

This equation expresses the relation between the ventilating pressure and a column of water contained in a U shaped tube, known as a water gage, and shown in Fig. 13. Next to the anemometer it is the most widely used instrument in ventilation.

Both ends of the tube are open to atmospheric pressure. One end registers the pressure of the intake air, the other end that of the return air. The unequal pressure causes the water to rise in one column and to fall in the other. By the aid of a scale graduated in inches, the vertical distance between the two water levels is read and this becomes the water gage reading. Three different scales may be used as shown in Fig. 13.

To convert the gage reading to pounds of ventilating pressure, it is multiplied by 5.2. The

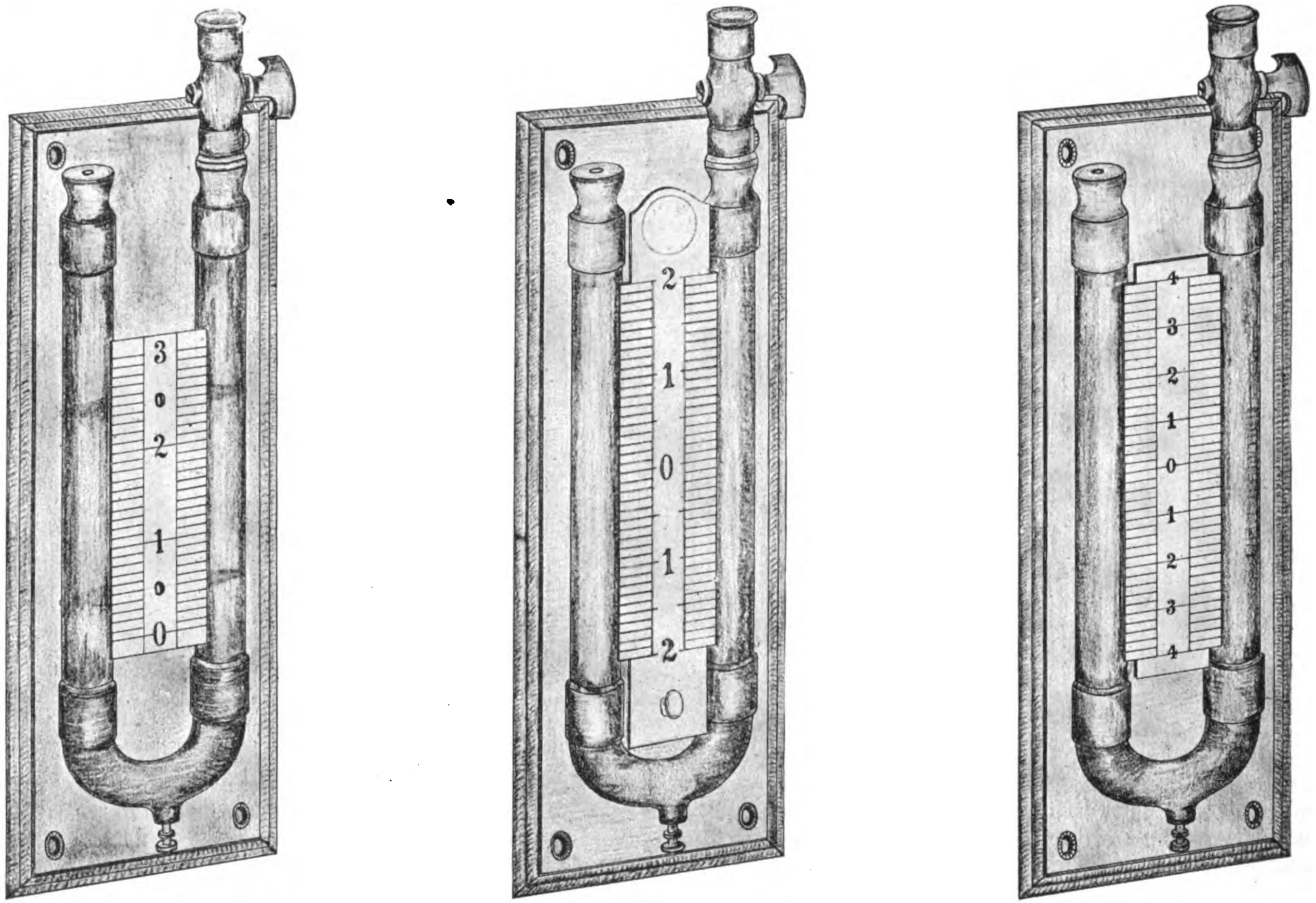

Fig. 13.

derivation of this factor is as follows: If we construct a cubical box, as in Fig. 14, having all three dimensions equal to 1 foot, and fill the box with water, the pressure on the bottom of the box will be that of the weight of 1 cubic foot of water, or 62.5 pounds. Each inch of water, vertically, will constitute 62.5÷12=5.2 (about) pounds of weight, or pressure, on the square foot of bottom. An inch of water gage reading, therefore, represents a pressure of 5.2 lbs. per square foot of surface, or, in other words, it requires a pressure of 5.2 lbs. per square foot to raise a column of water one inch.

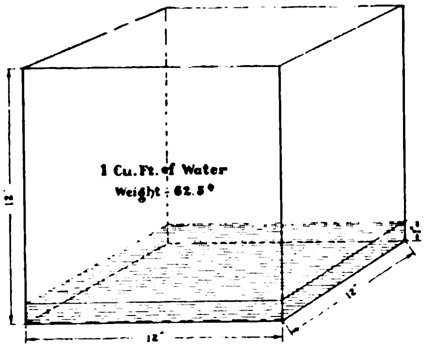

Fig. 14.

A high water gage indicates a high mine resistance and, therefore, a high ventilating pressure, or power on the air. Since the same factors govern the water gage as govern the pressure, anything that will effect a reduction in one will also decrease the other. While natural conditions will govern somewhat, it is the aim of several well managed corporations to circulate the first 100,000 cubic feet of air at a water gage of not over 1 inch.

The location of the water gage is a matter of prime importance. Sometimes it is placed in the first cross-cut between the main intake and return as shown in Fig. 15. In drift mines, owing to the cross-cut being driven close to the outcrop, this location proves satisfactory, but in shaft mines this would not provide a correct result since the air would travel a considerable distance to and from the outside to the first cross-cut, in the case of a deep shaft mine, this distance amounting to several thousand feet. A water gage placed in the cross-cut would correctly indicate the pressure necessary to complete the circuit inbye from the cross-cut, but no record would be had of the pressure

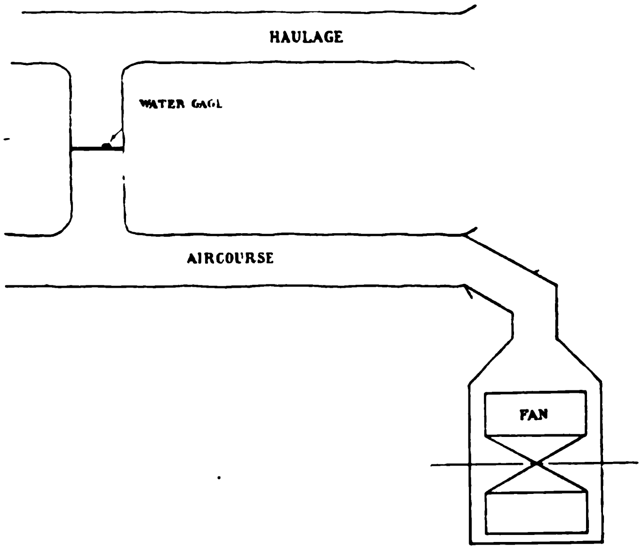

Fig. 15.

necessary to force the air from the outside to the cross-cut and its return from the cross-cut to the top of the up-cast shaft. The object of the water gage being to measure the total pressure necessary to circulate a given quantity of air, its theoretical position would be at the top of the air shaft. A more convenient location, and slightly more accurate, is to have the water gage placed in the engine or motor room as shown in Fig. 16. One tube is open to atmospheric pressure while the other records the pressure in the fan drift, pipe being run from the gage to a point sufficiently beyond the fan and turned so it is at right angles to the flowing air.

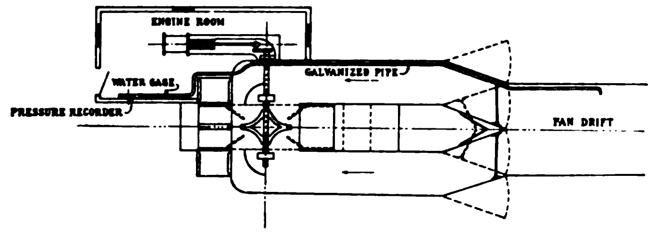

Fig. 16.

When it is desired to have a continuous record of the pressure and its variations, recording devices are used, in which a pen arm scribes the pressure on a chart having accurate time space covering a period of 24 hours, and operated by clock work. These charts are renewed daily, the ones removed being preserved as a record of the pressure variation. The two types commonly found are shown in Figs. 17 and 18.

Recorders are frequently used in conjunction with the water gage, the latter serving as a check on the chart readings. They are located in the engine room as indicated by Fig. 16, and connected to a continuation of the pipe leading to the water-gage. In some states, as Illinois, for instance, the mining law requires that a recording pressure gage shall be maintained in connection with each fan at all times.

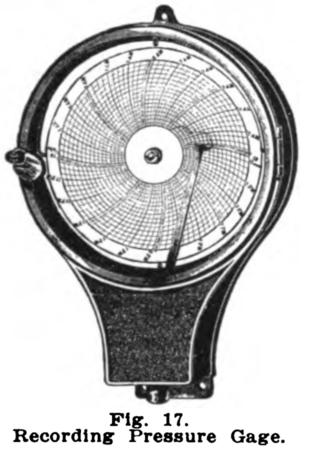

Fig. 17.
Recording Pressure Gage.

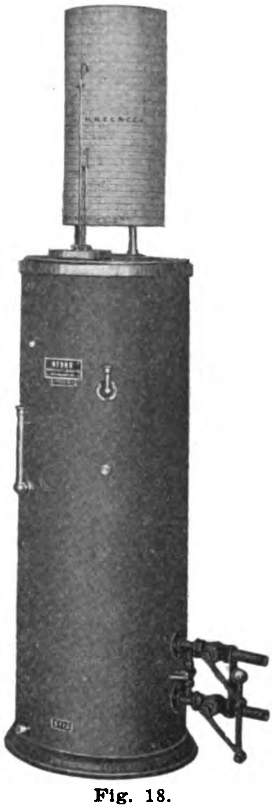

Fig. 18.
Pressure Recorder.

$$u = p\ a\ v$$

u=the unit of work, foot pounds per minute

p=the unit of ventilating pressure, pounds per square foot.

a=the area of airway in square feet.

v=the velocity of air current in feet per minute.

In this formula we have introduced, u, the unit of work, i. e., the work done in raising a pound one foot in height, or, pertaining to ventilation, the work done in applying a pound of pressure so as to move the mass of air one foot.

Let us conceive of an entry as being smooth and regular on its four sides as in Fig. 19. Further, imagine a wooden diaphragm constructed to fit neatly in the entry and moving through it, much like a piston through a steam cylinder, thus forcing the air on ahead. Before the diaphragm can be moved resistance must be overcome. This entails the application of pressure against the diaphragm, in this case the ventilating pressure, since it is the ventilating pressure which overcomes the resistance. Calling the area of entry, a, we have a total force exerted on the diaphragm equal to $p \times a = pa$. The distance through which the diaphragm will move in one minute is equal to v, the velocity of the air. The work done, or the power on the air, therefore, by definition is $pa \times v = pav$.

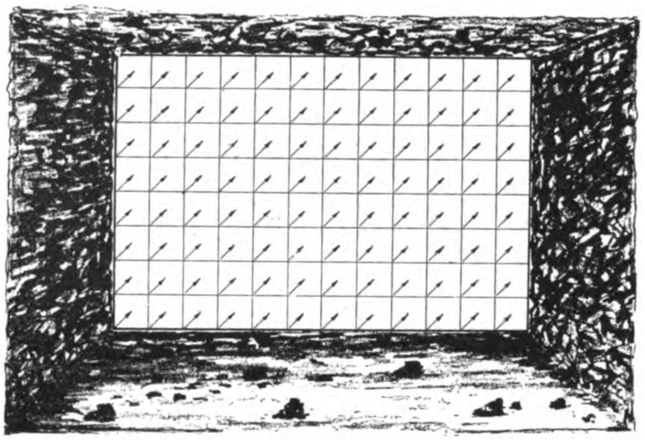

Fig. 19.

$$HP = \frac{u}{33{,}000}$$

HP=horsepower.

u=unit of work, foot pounds per minute.

The unit of work, u, is independent of the time requirement, that is when one pound is raised one foot, exactly one foot pound of work is done, no matter whether the time taken in raising the weight is one second, one minute, or one hour.

James Watt, the inventor of the steam engine, introduced the formula for horsepower, as a means of dealing with a larger unit which he stated as equal to 33,000 foot pounds of work done in one minute. Watt figured this as the work done by a horse walking at the rate of three miles per hour and raising a weight of 125 pounds at the same rate by a rope passing over a pulley. His formula does service in mine ventilation, not only to find the horsepower on the air, but furthermore, to find the horsepower of the engine driving the fan.

Derived Formulas

By the interchange of values additional important formulas may be derived from the six fundamental formulas. These need not be memorized, for if the manner of their derivation be thoroughly understood they can readily be arrived at when needed.

$R=pa$ (2)

$R=klov^2$ (3)

$pa=klov^2$ (7) (substituting pa for R in formula (3))

$p=\frac{klov^2}{a}$ (8) (dividing both sides of the equation by a)

$q=av$ (1); $v=\frac{q}{a}$; $v^2=\frac{q^2}{a^2}$; $v^3=\frac{q^3}{a^3}$

$p=\frac{klov^2}{a}$ (8)

$p=\frac{kloq^2}{a^3}$ (9) (substituting for v^2 in (8) its equivalent $\frac{q^2}{a^2}$ as derived from formula (1))

$p=\frac{klov^2}{a}$ (8)

$p=5.2\ i$ (4)

$i=\frac{klov^2}{5.2\times a}$ (10) (substituting for p in (8) its equivalent 5.2 i as derived from formula (4))

$p=\frac{kloq^2}{a^3}$ (9)

$p=5.2\ i$ (4)

$i=\frac{kloq^2}{5.2\times a^3}$ (11) (substituting for p in (9) its equivalent 5.2 i as derived from formula (4))

$q=av$ (1)

$u=pav$ (5)

$u=pq$ (12) (substituting for av in (5) its equivalent q as derived from formula (1))

$p=\frac{klov^2}{a}$ (8)

$u=pq$ (12)

$u=\frac{klov^2\times q}{a}=klov^3$ (13) (substituting for p in (12) its equivalent $\frac{klov^2}{a}$ as derived from formula (8) and substituting further for $\frac{q}{a}$ its equivalent v)

$q=av$; $v^3=\frac{q^3}{a^3}$ (1)

$u=klov^3$ (13)

$u=\frac{kloq^3}{a^3}$ (14) (Substituting for v^3 in (13) its equivalent $\frac{q^3}{a^3}$ as derived from formula (1))

$u=pav$ (5)

$HP=\frac{u}{33{,}000}$ (6)

$HP=\frac{pav}{33{,}000}$ (15) (substituting for u in (6) its equivalent pav as derived from formula (5))

$u=pq$ (12)

$HP=\frac{u}{33{,}000}$ (6)

$HP=\frac{pq}{33{,}000}$ (16) (substituting for u in (6) its equivalent pq as derived from formula (10))

A study of these formulas reveals that nearly all the rules in ventilation are derived directly therefrom. Thus,

The pressure varies as the square of the quantity of air in circulation, from formula (9).

The water gage varies as the square of the velocity, from formula (10).

The water gage varies as the square of the quantity of air in circulation, from formula (11).

The horsepower required to ventilate a mine varies as the velocity cubed, from formula (13); or as the quantity cubed, from formula (14).

Problems in Proportion.

All mine ventilation formulas are made up largely of variables, any of which, if changed, has an effect on the final result. For instance, the formula $R=klov^2$ tells us that the resistance varies directly as the coefficient of friction, and as the length and the perimeter of the airway, that is, if any of these are increased or decreased the resulting value of the resistance is increased or decreased. It states further that the resistance varies directly as the square of the velocity. Any increase or decrease in the rate of air travel, therefore, has a far greater effect on the resistance than would result from a similar increase in the factors k, l, or o.

Problem. If the total resistance is 400 lbs. in passing a current of air through an entry 8 ft. x 10 ft. and 1200 feet long at a velocity of 600 feet per minute when k equals .00000001, what will the resistance be when the entry becomes 2000 feet long, the velocity decreased to 400 feet, and the coefficient of friction increased to .00000002?

Solution. Because of the change in values of the coefficient of friction, the new resistance will be,

$400\times\frac{.00000002}{.00000001}$ (varies directly as the first power of the coefficient of friction)

Because of the change in the length of entry, the new resistance will be,

$400\times\frac{2000}{1200}$ (varies directly as the first power of the length)

Because of the change in velocity, the new resistance will be,

$400\times\frac{400}{600}\times\frac{400}{600}$ (varies directly as the square of the velocity)

By combining the three expressions, we have,

$$400\times\frac{.00000002}{.00000001}\times\frac{2000}{1200}\times\frac{400}{600}\times\frac{400}{600}=593\text{ lbs.}$$

Ans.

Passing to formula (9) $p=\frac{kloq^2}{a^3}$. This formula means clearly that the ventilating pressure varies directly as the first power of the coefficient of friction, the length and perimeter of the airway; directly as the quantity squared; and inversely as the area cubed. By inversely we mean that any increase in the area will decrease the ventilating pressure, or conversely, that a decrease in the area will increase the ventilating pressure.

Problem. If a ventilating pressure of 10 lbs. is necessary to circulate 60,000 cubic feet of air per minute in an airway 8 ft. x 10 ft. and 4000 feet long, what pressure will be required to pass 80,000 cubic feet in an entry 5 ft. x 10 ft. and 6000 feet long?

Solution. Because of the change in the length of entry, the new pressure will be,

$10 \times \frac{6000}{4000}$ (varies directly as the first power)

Because of the change in perimeter, the new pressure will be,

$10 \times \frac{30}{36}$ (varies directly as the first power)

Because of the change in quantity, the new pressure will be,

$10 \times \frac{80000}{60000} \times \frac{80000}{60000}$ (varies directly as the square)

Because of the change of area, the new pressure will be,

$10 \times \frac{80}{50} \times \frac{80}{50} \times \frac{80}{50}$ (varies inversely as the area cubed)

By combining the four expressions, we have,

$$10 \times \frac{6000}{4000} \times \frac{30}{36} \times \frac{80000}{60000} \times \frac{80000}{60000} \times \frac{80}{50} \times \frac{80}{50} \times \frac{80}{50} = 90.8 \text{ lbs.}$$

How To Determine the Value of K

From formula (8), $p = \frac{klov^2}{a}$, we can derive an expression for the value of k, thus,

$$k = \frac{pa}{lov^2}$$

By selecting an entry on which rooms have not been driven, each of the variables in the second part of the equation may be found and substitution then be made in the formula.

p is found by multiplying by 5.2 the reading of a water gage placed at C in Fig. 20.

a is found by measuring the area at several points and taking the average of these.

l is found by measuring the distance from the water gage to the last break through and doubling the distance so found.

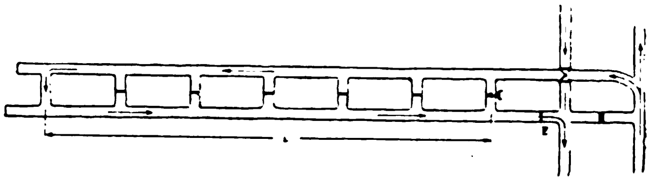

Fig. 20—Entry Used to Determine the Value of the Coefficient of Friction.

o is derived from the measurements taken when finding the area.

v is found by a reading of the anemometer.

By substituting in the formula all the factors thus derived, the value of k may be found. It is likely that several entries on which rooms have not been driven can be found and the value of k determined for each of these. The more nearly these entries represent the usual conditions as to irregularities, timbering, roof falls, etc., the more reliable will be the resulting value.

In such a determination entries are selected on which rooms have not been driven, since once the air is deflected into the rooms, the factors l, o, and v are difficult to determine. By placing a box regulator at E varying quantities of air can be thrown into the side entry, thus producing a series of water gage and velocity readings. A computation made with each set of different factors should show approximately the same value of k and furnish a check on the work.

In addition to computing the value of k from the series of observations, further interest is lent to the experiment by proving the well known law as stated in derived formula (11), i. e., the water gage varies as the square of the quantity of air in circulation. Changing the amount of air passing is made possible by the use of a regulating door at E, as before mentioned. All that is necessary is to substitute the varying expressions for quantity in the formula $i = \frac{kloq^2}{5.2 \times a^3}$ and observe how closely the computed value agrees with the value shown at C on the water gage.

DEVICES FOR CONDUCTING AND CONTROLLING AIR CURRENTS

Stoppings

Stoppings are seals placed in crosscuts between air currents traveling in opposite directions. They are made of wood, slate or gob, brick, tile or concrete. Wood stoppings are mostly found in entries of lesser importance. Masonry is commonly used on the main entries, and while more expensive to build than wood, they prove economical in the long run owing to the tightness of the stopping. The difficulty in making tight stoppings is largely responsible for the variation in mining laws governing their prevalence, thus the Pennsylvania requirement is a stopping for each 105 feet of entry driven, while the Illinois law reduces this distance to 60 feet. An interesting experiment at any mine, and one that will frequently disclose the reason for insufficient air on an entry, is to carefully measure the quantity of air entering the split and then compare this with the quantity passing through the last cross-cut. The difference in the two values will represent the air passing through leaky stoppings.

The indifference to the value and importance of tight stoppings is surprisingly shown in a series of sixteen tests conducted in Illinois.* The best of the tests showed that but 33.5 per cent. of the air entering the mine reached the last cross-cut, while in three instances less than 10 per cent. was recorded. When it is recalled that a number of large operating companies figure a horsepower as costing about $40 per year, the economy in building stoppings of tight and durable material becomes at once apparent.

Checkers

In order to deflect the air current from the entry into the rooms, curtains or checkers of brattice cloth are used. These are made of a number of overlapping strips from 12 to 18 inches in width and suspended from a cap piece in the entry. The loose strips permit live stock and cars to pass through readily but offer sufficient obstruction to the air current to force it through the rooms.

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*See Bulletin 99, Mine Ventilation Stoppings, by R. Y. Williams, Bureau of Mines.

Brattices

Brattices are used in rooms and entries to conduct the air from the last cross-cut to the face. See Fig. 21.

They are sometimes constructed of wood though more generally of a non-inflammable cloth nailed to posts and cap pieces. The tightness of the brattice against the leakage of air depends both on the texture of the cloth and the care taken in its construction. They are mainly used when gas is encountered at the face of the working or to ventilate advance workings between cross-cuts.

A new system of ventilation for driving single entries, sinking shafts, clearing gas pockets, or dead ends of bad air makes use of flexible tubing.

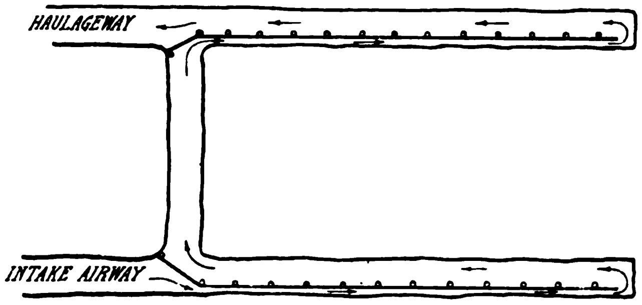


Fig. 21.

The tubing is run near the working face and capacities up to 10,000 cu. ft. of air per minute have been attained. Its use is especially valuable to overcome the noxious effect of powder fumes. Just before shooting the tubing is rolled back a safe distance from the face. After the blast the air is turned on, the tube unrolls itself, and clears the smoke is a very short time.

Doors

Doors are used to direct the travel of an air current in a selective route. They are constructed of wood and when hung on the door frame are made to be self closing by setting the lower hinge out (toward the entry pillar) from a line vertical to the upper hinge. The direction of closing is always with the air current.

When the location of a door is on the main haulage the mining law requires an attendant, whose duty it is to see that it is open only for the passage of cars. During the time of passage ventilation is suspended in the side entry. It is important, therefore, that no door should remain open longer than necessary to permit the passage of cars.

In order to eliminate risks from careless attendance and in the interest of economy, automatic mine doors have come largely into use. See Fig. 22.

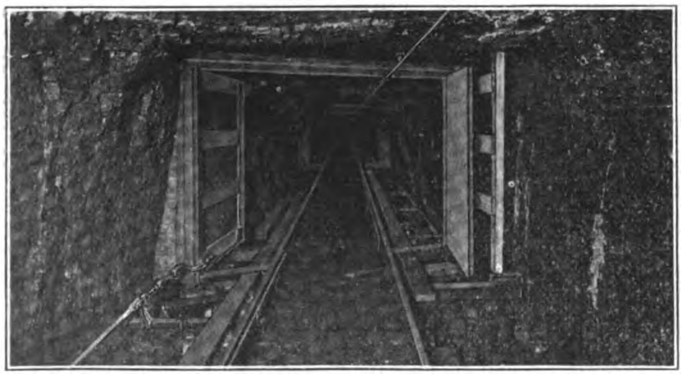


Fig 22.

These are opened by pressure of the tread of the locomotive wheel and close immediately after the passing through of the trip. Being entirely automatic trapper boys are unnecessary. In contrast to the latter they are certain in action, suspend ventilation a minimum amount of time and effect a considerable saving in operating cost.

Regulators

Regulators are devices used to govern the quantity of air passing in a section of the mine. They are of two kinds, the box regulator and the door regulator. The box regulator shown in Fig. 23 is the one in common use. It is sometimes placed in the last cross-cut, though a preferable location is in the air course as shown in Fig. 24, since once located here it need not be moved as the entries advance. All the air used in the ventilation of the section must pass through the opening in the regulator, the size of which is varied by means of a sliding cover. The box regulator is equally effective with either the exhaust or force system of ventilation.

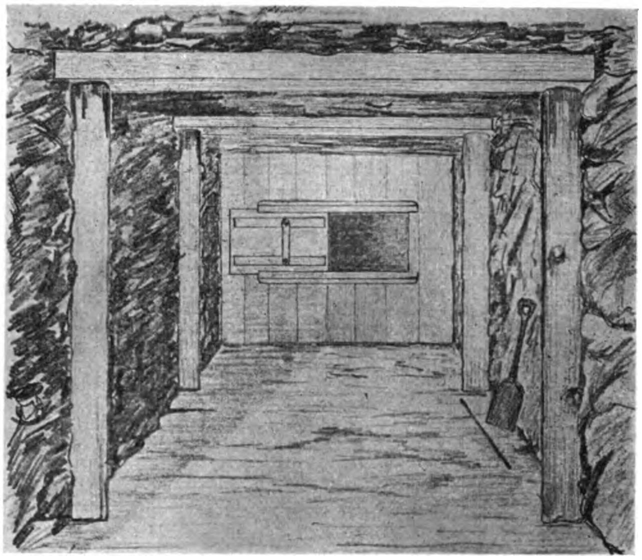


Fig. 23—The Box Regulator.

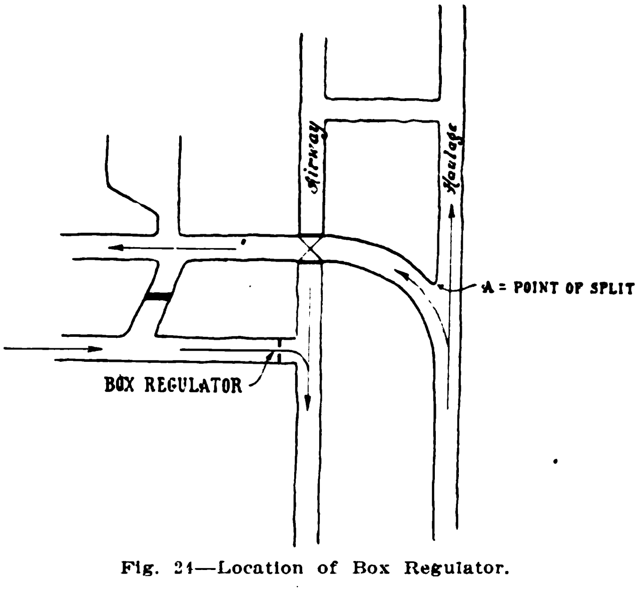


Fig. 24—Location of Box Regulator.

The door regulator differs from the box regulator in the point of location and furthermore in that it consists of a solidly constructed door which can be swung from side to side of the entry, the quantity of air passing being proportional to the space permitted (area) between the door and the rib. See Fig. 25. It will be obvious from an understanding of this means of regulation that a door regulator at the point of split is not adapted to the exhaust system of ventilation since in this system the point of split is on the haulage way, at which place no regulator could be tolerated. In the force system of ventilation, for which the door regulator is particularly adapted, the point of split is in the airway. A regulator placed here offers no inconvenience to any branch of operation. It will however be noted that with a door regulator located as shown in the figure, and assuming the exhaust system of ventilation, regulation can be effected as well with the door regulator as with the box regulator, since the area permitted for the passage of the return air can be regulated at will.

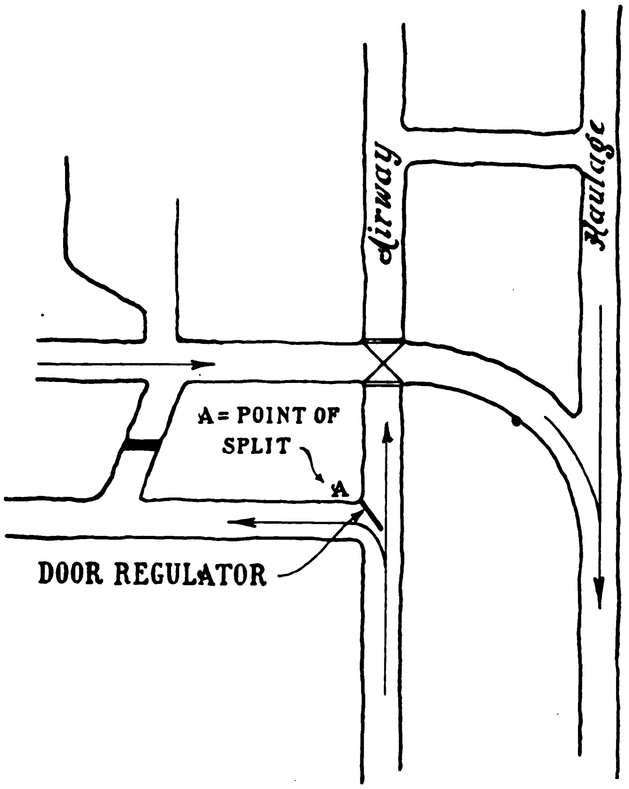


Fig. 25—Location of Door Regulator.

The door regulator has often had claimed for it the merit of regulating air quantities with the introduction of less resistance than in the case of the box regulator. Small tests are said to have shown from 5 to 7 per cent. economy in power though no details are given as to the manner and means of conducting the tests. Once the door regulator has been set to pass the desired quantity of air, it is locked in position by spikes driven into the roof on either side of the door, wedging between the roof and door, propping, spikes driven into cross pieces laid on the bottom diagonally across the air course, or a combination of the above means.

Regulators of any type are placed only on those splits whose resistance is low and which would, therefore, naturally receive the greatest quantity of air. Since the reason for this low resistance is in all probability due to the shorter length of entry, it follows that, unless regulators were used, entries fully developed and employing the greatest number of men would get the least air.

Overcasts

In order to effect a division of air current an overcast is used. This may be described as an air tight device which permits the crossing of fresh and contaminated air currents. They are constructed of wood, tile, brick, stone, or combinations of these materials. Wood overcasts are now generally prohibited by mining laws. Two methods of constructing overcasts are shown in Figs. 26 and 27. The overcast in solid strata, while most resistant of all to destruction by an explosion, is practically prohibited by its cost. Fig. 27 shows the type most commonly found. The side walls are built of hollow building tile, brick, stone or concrete. The top may consist of steel rails reaching from wall to wall and spaced at the proper distance to accommodate a row of bricks laid on face and resting on the base of the rail. After the entire top is thus covered a layer of cement grout is spread over the bricks and rails, thus making an effective seal against the leakage of air. Frequently a form is built in the entry and a thick concrete slab reinforced with old rails, rope, bars,

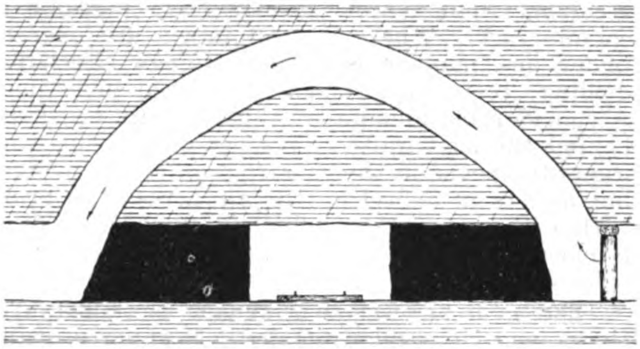


Fig. 26—Overcast in Solid Strata.

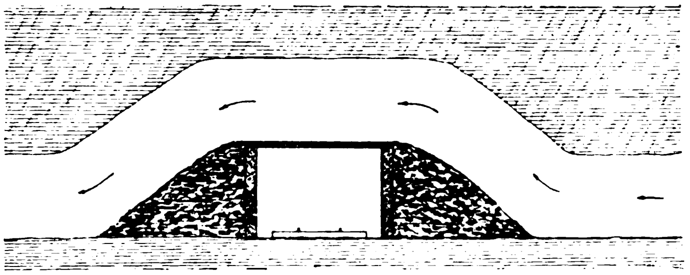


Fig. 27—Common Type of Overcast.

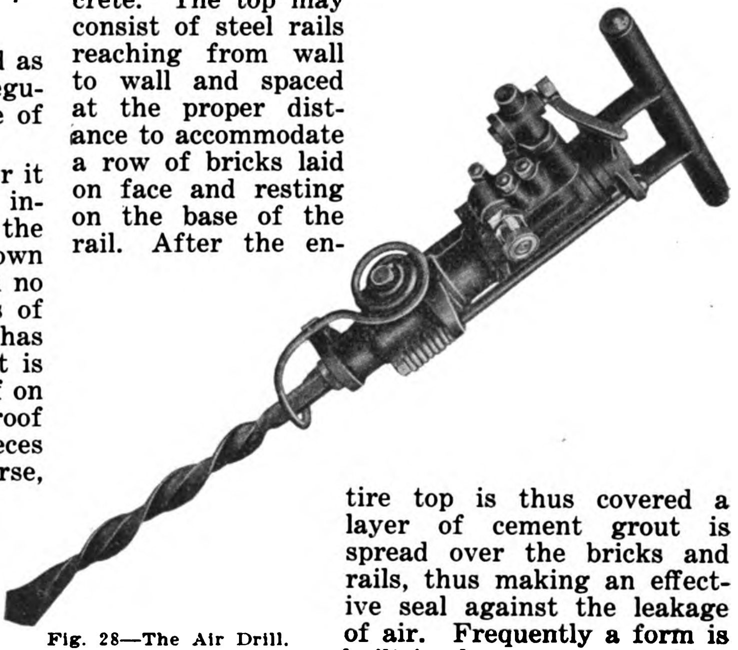


Fig. 28—The Air Drill.

etc., is used to span the entry. The arched cover has greater strength but requires additional excavation of top and is therefore costly to build.

The cost of an overcast will depend upon the amount of top rock removed (the area over the bridge should always be equal to the entry area), the distance it must be removed for stowing and the type of overcast selected. The top rock is first drilled and then shot. Drilling may be done by hand, but this is a laborious and costly method. The electric drill, is much used for this work. In electrically equipped mines, air drills may be used, receiving their power directly from portable air compressors. Where several mines are operated under one management, the savings effected in drilling costs soon repays the initial investment. A considerable amount of rubbish may be stowed behind the side walls. This not only reduces one item of expense in the construction of the overcast but assists in deflecting the air across the bridge with a lesser resistance effect than where no filling is placed, thus allowing the air to impinge on the side wall.

The overcast selected should be substantial, cheap, and simply constructed. Nothing is gained by an elaborate construction, in fact such installations, owing to their excessive costs, discourage the placing of subsequent overcasts. In several instances the writer has found exaggerated conceptions as to the costs of overcasts, due perhaps to the high costs of experimental installations, which figures are passed about and accepted as the average. It is probably true that this misconception on costs, more than indifference to the several benefits which are attainable by their use, has held back the more general adoption of overcasts in many mining localities. Balanced against this first cost there at once becomes operative the savings made in dispensing with trapper boys. A simple mathematical computation will show that an overcast pays for itself in from six months to a year. Nor is economy the only advantage. A study of the mine explosions, which have taken place in this country during the past fifteen years, will reveal many instances where such have followed as the result of carelessness in permitting trap doors to remain open, in some cases being forcibly held open with a block or prop, thus shutting off an entire section of a mine from air, and permitting the accumulation of explosive gases. Only slightly less harrowing than explosions are the tolls collected in dribbles, where drivers, motormen and trapperboys are maimed or killed in the passage of trips through the door. In one year Pennsylvania alone has reported as many as 48 fatal accidents with hand trapped doors.

Since overcasts permit splitting the air current, avoid the use of trap doors, pay for themselves in a short period of time, add to the safety and health of the workmen, and are reliable and unfailing in their action, it may appear that they should be used at each working entry turned off, thus utilizing to the utmost their good qualities. Such a proposition soon reveals its own weakness, for the allowance to each entry of a split of air would divide the total quantity into such relatively small amounts that the velocity would drop too low to remove the smoke and gases. (According to formula q=av.) The minimum velocity at which an air current will remove gases is oft times stated as three feet per second or180 feet per minute. When, by excessive splitting, the velocity falls below this figure the remedy plainly is to make a lesser number of splits by allotting to each split not one, but two or more entries. An arrangement such as this necessarily introduces doors into the system, but these doors are placed in the room entry and not in the main entry. This arrangement is illustrated in Fig. 29, to which reference should now be made.

It is generally agreed that overcasts should be so well constructed as to offer an effective resistance against destruction in case of an explosion. Overcasts are not, however, designed to resist extreme pressures, since in case of a very destructive explosion any overcast in the path of violence would be sure to be destroyed. In order to save the overcast the practice of building adjacent stoppings of weak material is sometimes followed, the idea being that the blast would blow these down and quickly establish an equality of pressure on both sides of the overcast. The same effect is striven for by placing explosion doors in the overcast, as shown in Fig. 30. These doors are hinged at the side and close at the center. Tightness against leakage is attained by sealing the joints with mortar or a packing of fine sand. In case of an explosion the doors can blow either up or down,

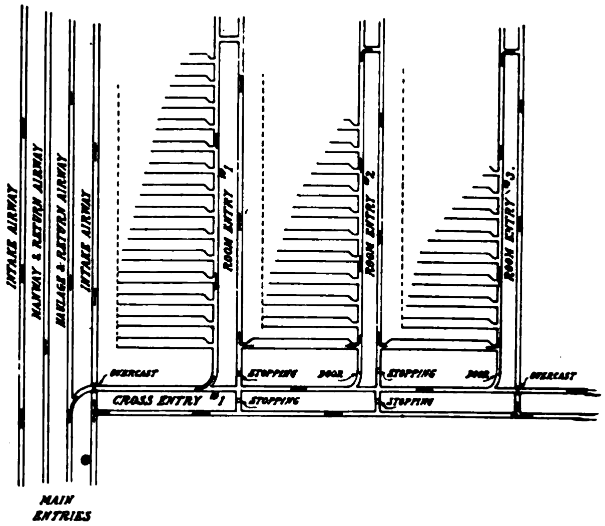
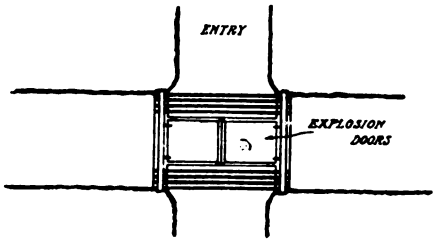


Fig. 29—Showing a Split Ventilating Three Entries, Requiring One Overcast and Two Doors.



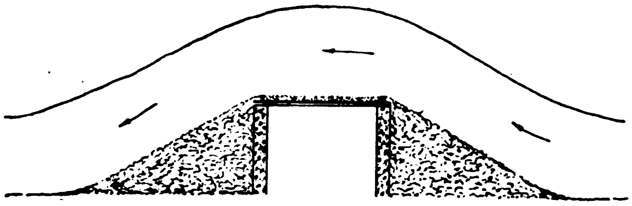


Fig. 30—Overcast with Explosion Doors.

depending upon the origin of the pressure, and thus save the overcast from destruction. In the restoration of ventilation the overcast is quickly brought back to its original effectiveness.

When excavation is done in the bottom for the purpose of crossing air currents it is known as an undercast. They are seldom found and have deservedly been relegated almost to oblivion. Owing to the tendency of water to collect in them, thus closing off the passage way, they are considered a menace and will not be discussed here.

HUMIDITY OF MINE AIR MEASURED BY THE HYGROMETER

What the Wet-and-Dry-Bulb Hygrometer Indicates

The wet-and dry bulb hygrometer shows the difference between the readings of the two thermometers. The dry-bulb thermometer, of course, indicates the actual temperature of the air. The reading of the wet-bulb thermometer is lowered by the evaporation of the water from the little sack surrounding this bulb, and which is kept moist by the water drawn up through the wick from the vessel below.

The difference of temperature indicated by these two thermometers depends on the rapidity of the evaporation of the water from the wet bulb. The evaporation is more rapid in dry than in wet air; and the difference of reading is, thus, an index or measure of the degree of saturation of the air. When the air is fully saturated with moisture there is no evaporation from the wet bulb and the readings of the two thermometers are the same. The difference increases with the dryness of the air.

Difference Between Dry and Wet Bulb

Reading of dry bulb ther.	Degrees																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	17.5	18	18.5	19	19.5	20	20.5	21
Degrees	Relative Humidity																								
65	95	90	85	80	75	70	66	62	57	53	48	44	40	36	32	28	25	23	21	19	17	15	13	12	10
66	95	90	85	80	76	71	66	62	58	53	49	45	41	37	33	29	26	24	22	20	18	17	15	13	11
67	95	90	85	80	76	71	67	62	58	54	50	46	42	38	34	30	27	25	23	21	20	18	16	15	13
68	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	31	28	26	24	23	21	19	17	16	14
69	95	90	86	81	77	72	68	64	59	55	51	47	44	40	36	32	29	27	25	24	22	20	19	17	15
70	95	90	86	81	77	72	68	64	60	56	52	48	44	40	37	33	30	28	26	25	23	21	20	18	17
71	95	90	86	82	77	73	69	64	60	56	53	49	45	41	38	34	31	29	27	26	24	22	21	19	18
72	95	91	86	82	78	73	69	65	61	57	53	49	46	42	39	35	32	30	28	27	25	23	22	20	19
73	95	91	86	82	78	73	69	65	61	58	54	50	46	43	40	36	33	31	29	28	26	24	23	21	26
74	95	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	32	30	29	27	25	24	22	21
75	96	91	87	82	78	74	70	66	63	59	55	51	48	44	41	38	34	33	31	30	28	26	25	23	22
76	96	91	87	83	78	74	70	67	63	59	55	52	48	45	42	38	35	34	32	30	29	27	26	24	23
77	96	91	87	83	79	75	71	67	63	60	56	52	49	46	42	39	36	34	33	31	30	28	27	25	24

Relative Humidity of Air

As previously explained the relative humidity of air is expressed by the ratio of the actual vapor pressure in the air at the time, to the saturated vapor pressure. The following table gives the percentage of saturation or the hygrometric state of air for various differences of readings, at different temperatures.

To use the table, find the observed temperature of the air, in the left-hand column, and the difference of the observed readings of the wet-and-dry-bulb thermometers, at the top of the table; the corresponding number in the table is the percentage of saturation which expresses the degree of humidity of the air. For example, if the dry-bulb temperature is 70 deg. and the wet-bulb 64 deg. F. the difference of readings is 6 deg. and the corresponding humidity as taken from the above table is 72 per cent.

The Application to Mining

The moisture which air can carry varies directly with its temperature, that is, air at 80 deg. F. can carry more moisture than air at 20 deg. F. Let us assume the average temperature of mine air to be 60 deg. F. the whole year around. During the warm summer months air entering the mine at 80 deg. F. comes in contact with the top and sides of the entry and is cooled to the temperature of the mine. Because of the drop of 20 degrees in temperature, the quantity of water vapor the air can carry is reduced and moisture may be deposited on the top and sides, on the same principle as dew is deposited on blades of grass during the warm summer nights. The mine is then said to be "on a sweat." If the warm air entering the mine is at a low humidity, that it, it is carrying but a small percentage of water vapor, the effect of a drop of 20 degress in temperature may be merely to raise the humidity of the air, but not, however, to the dew point. In this event no moisture will be deposited.

In the winter months the conditions are reversed. Air entering the mine, say at 20 deg. F., gradually reaches a temperature equal to that of the mine. With each increment in temperature given to the air its capacity for moisture is increased, and this moisture is supplied as the air passes over the wet sections of the mine. The effect is to make these sections dry, thereby increasing the danger from the fine coal dust, which, when free from moisture, rises into the air current and finds lodgment in the timbers and irregular surfaces of the coal. For this reason it is advocated that in all mines whichare dry and dusty, moisture be supplies to the mine during the cold months by means of exhaust steam, sprays, sprinkling with a hose or by a pump mounted on a movable truck and forcing the water through pipes or sprays under pressure.

MINE FANS

Mechanical devices for the propulsion of air against resistance may be classed as exhausters, blowers and fans. The first two named have no place in mine ventilation and only the last will be considered here.

There are two types of fans used, disc and centrifugal.

Disc, or propeller fans, are those in which the air is drawn in axially and discharged axially. Air from the rear rushes through the blades to fill the void left by the displaced air, thus creating a continual flow. The vanes vary from 4 to 12 in number and are set at an angle with the plane of rotation. See Fig. 31. They are surrounded by a cast-iron or sheet steel casing with just sufficient clearance to avoid touching. The fan is set at the opening of the air course, or else in a fan drift leading to the opening, all spaces beyond the casing being closed by brick work or wood.

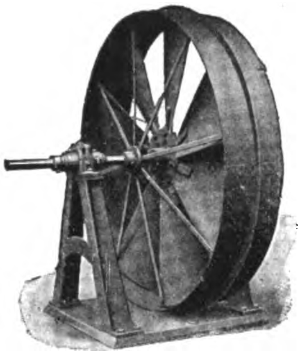


Fig. 31.

Disc fans have in their favor (1) low initial cost, (2) rapidity and cheapness of installation, no expensive foundations being required (3) well adapted for use in emergencies, such as restoring ventilation after an explosion (4) easily moved from place to place (5) may be run readily by steam, electricity, or gasoline. The pressure and volume are, however, limited, a reasonable performance being 50,000 cubic feet of air against a water gage of 1 inch, though in sizes up to 12 feet diameter a volume of 100,000 cubic feet per minute may be had. They are particularly well adapted for mines of lesser size, or for large mines during the early stages of development. They are also used as "booster" fans to assist the movement of air near the end of a split or at some distant point in the workings where ventilation is poor.

Centrifugal fans, in different forms, have been built for over 200 years, being used originally for mine ventilation and later for the ventilation of tunnels. Most of the early designs used in mining were made by French and Belgian engineers, since in these countries, owing to the thin seams mined, furnaces proved inadequate for circulating a sufficient quantity of air. Attention was of necessity centered on the use of fans.

In the centrifugal type air is drawn in axially and discharged tangentially. The principle on which all these fans work is known as centrifugal motion. The air within the blades, having weight, and being twirled rapidly about, has developed within it a certain amount of centrifugal force, the same as experienced in twirling a stone fastened to a string. The mass of air flying off at a tangent, puts pressure on the air at the outer circumference of the blades and causes it to flow along the fan casing and into the fan drift or expanding chimney, as the case may be. The difference in pressure between the center and the circumference of the fan, while in revolution, produces a steady flow of air.

The pressure developed by a fan depends upon the peripheral speed of the fan, and this in turn depends upon the diameter of the fan and the number of revolutions made per minute. The quantity of air produced depends upon the breadth of fan, its diameter, number of revolutions per minute and the pressure developed.

The Guibal Fan

This fan was designed about 70 years ago by M. Guibal, an eminent Belgian mining engineer. It is usually constructed of large diameter, varying from 20 to 45 feet, the width being ¼ to ½ of the diameter. The rectangular blades, or vanes, usually eight or ten in number, are not arranged radially, but are set backward from 30 to 40 degrees, as will be seen from Fig. 32, that is, they are bolted to arms which are fixed to an octagonal cast iron boss. In large fans the blades are made of wrought iron, while for small sizes they may be made of wood.

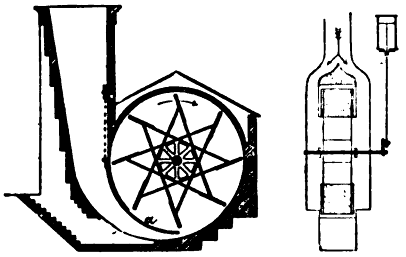


Fig. 32—The Guibal Fan. (Illustration from Kerr's Practical Coal Mining.)

The Guibal fan was the first to introduce the expanding chimney, the purpose of which is to reduce the velocity of the air as it leaves the fan. This increases the efficiency, inasmuch as the power required to discharge the air from the fan varies as the square of the velocity. Guibal also made use of the circular envelope, or casing, which was originated by M. Leterot. The purpose of the casing is to isolate the machine from the mass of air which surrounds it and thus avoid the irregular re-entrance of air. At first the casing was circular, rather than spiral, as used later. An additional distinguishing feature of the fan was the use of a shutter, a, to regulate the opening for the flow of air. The shutter was movable to enable it to be placed in the most favorable position, which was attained when a maximum was reached, beyond which eddies would be formed within the fan space and the air begin to re-enter intermittently after the passage of each vane. The original shutter, having a straight edge, caused shock to the fan. The Walker shuter, now adopted, is formed like an inverted V and allows a gradual instead of a sudden release of air as each blade passes the enclosed part of the casing.

Nearly all Guibal fans were built with the heel of the blade bent forward in the direction of rotation, thus tending to lessen the loss of energy by shock of the entering air. They may have single or double inlets, though more frequently single. They have good efficiencies and are suitable for large volumes of air at low water gages, varying from 2 to 5 inches. The speed of the fan varies with the size, a fan 30 feet in diameter being usually driven at from 50 to 60 revolutions per minute, and one of 40 to 45 feet diameter at 40 to 50 revolutions per minute.

The Guibal fan attained its greatest popularity in the anthracite regions. The chief objections to its use are its large size, expensive foundations and consequently heavy initial cost. Its great width makes necessary the carrying of a very heavy weight on a long length of driving shaft, and since this can be supported only at the ends, it requires heavy shafting if breakage is to be avoided.

The Waddle Fan

This is an open running type of fan, which, while retaining the principle of centrifugal motion, is distinguished because it is not enclosed in a casing and air is discharged at all points of the circumference instead of only at one point. See Fig. 33. In appearance it is a very flat hollow truncated cone with the base closed and a central opening on the other side. This opening is connected to the airway, and the air discharged directly into the atmosphere. Originally the blades were curved backwards from the direction of rotation, but in the later types are radial. The width of blade is reduced at the periphery by inclining the inner disc toward the outer, at such an amount that the products of the angular velocity, multiplied by the sectional area at any point, are constant throughout the fan. In more recent designs the velocity of the discharged air is reduced and a saving in power made by the addition of a diverging outlet, which extends beyond the external ends of the blades. Its diameter varies from 20 to 50 feet and its speed is from 40 to 60 revolutions per minute. The Waddle fan is the best of this class of ventilator and is much used in England, but never gained popularity in this country.

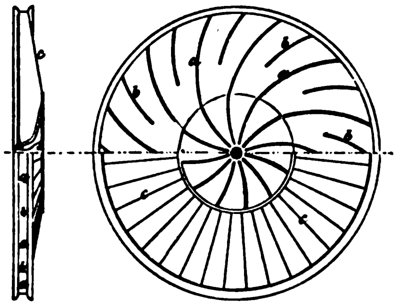


Fig. 33—Waddle Fan. (Illustration from Kerr's Practical Mining.)

Capell Fan

The Capell fan, invented in 1883, was peculiar in that it was divided both vertically and horizontally into chambers. Air on entering the eye met the inner blades and was thrown at a high velocity through port holes in the horizontal division, which consisted of a cylinder, concentric with the shaft and separating the six inner blades from the six outer ones. The velocity of the air, on leaving the tips of the outer blades, is reduced as it is discharged into a spiral volute chamber and finally into the atmosphere by means of an expanding chimney. All sizes above eight feet in diameter are constructed with a double inlet, a stiff plate serving to entirely separate the air received on one side from that on the other.

More recent designs of Capell fans show many deviations from the original. Outer blades have been compounded—beginning at the shaft they lie in a radial plane for about one-half of the distance to the outer circumference and then rapidly recede from the radial plane backward from the direction of rotation. In other designs auxiliary blades, called tail wings, have been introduced. In the British type the concave side of the vane opposes the air. The American type differs somewhat in the arrangement of tail blades. It is made in sizes varying from 7 feet by 2 feet to 18 feet by 6 feet. The mechanical efficiency is variously rated, though 70 per cent is about right.

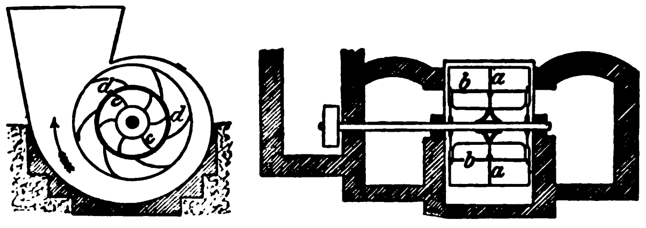


Fig. 34—The Original Capell Fan. (Illustration from Kerr's Practical Mining.)

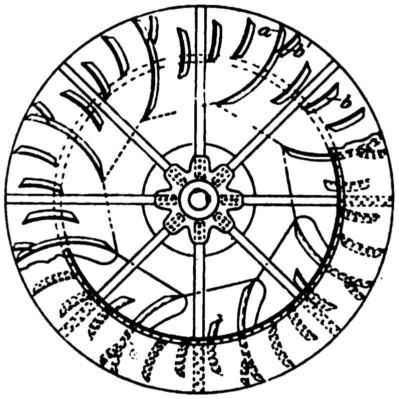


Fig. 35—American Type of Capell Fan. (Illustration from Redmayne's Modern Practice in Mining.)

In the inlet orifice of the wheel, each vane had attached to its outer edge a small vane which is curved forming a sort of scoop to assist the air into the fan.

Unlike the Guibal or Waddle fans, it is run at high speeds, frequently reaching 150 revolutions per minute and over. In its modified forms it has been much used in the bituminous coal fields of Pennsylvania.

Modified Types

The early designs of Nasmyth, Guibal, Waddle and Capell have been much improved upon, giving us more efficient fans, some having the distinctive features of one type, and some of the other. The aim of all designers has been to so proportion blades with respect to shape, depth and curvature, eye openings, spiral casing, evase chimney, etc., that the air may enter and leave the fan without shock and that there shall be no eddying, or return of air to the fan. The Clifford, Lepley, Beard-Stine, Allis-Chalmers and Vulcan fans are familiar types, each bearing many improvements over the pioneer ventilators, which have combined to make them more economical of power.

High Speed Fans

A noticeable tendency amongst American manufacturers has been to get away from the heavy, slow speed, large diameter fans, with their necessarily expensive foundation requirements, to the lighter weight, high speed, small diameter fan. A distinguishing feature of all these fans is the large diameter of inlet as compared with the diameter of wheel. From 42 to 64 vanes, or blades, are employed, their radial length ranging from 1-8 to 1-16 of the wheel diameter. Surrounding the wheel is a spiral casing as in the other forms.

The Sirocco is the original fan of the multi-bladed, or turbine type, making its advent in Great Britain 17 years ago and in the United States 10 years later.

The Lepley, Jeffrey, Sullivan, Robinson, Buffalo, Vulcan and Sturtevant fans are high speed, and though all of this type are of relatively small diameter, they have given some wonderful performances of large volumes delivered against a water gage higher than is usually encountered in American practice.

Installation of Fans

There are four general types of fan installations. See Fig. 36.

1. Single inlet exhausting, as shown in Arrangements 1 and 2.

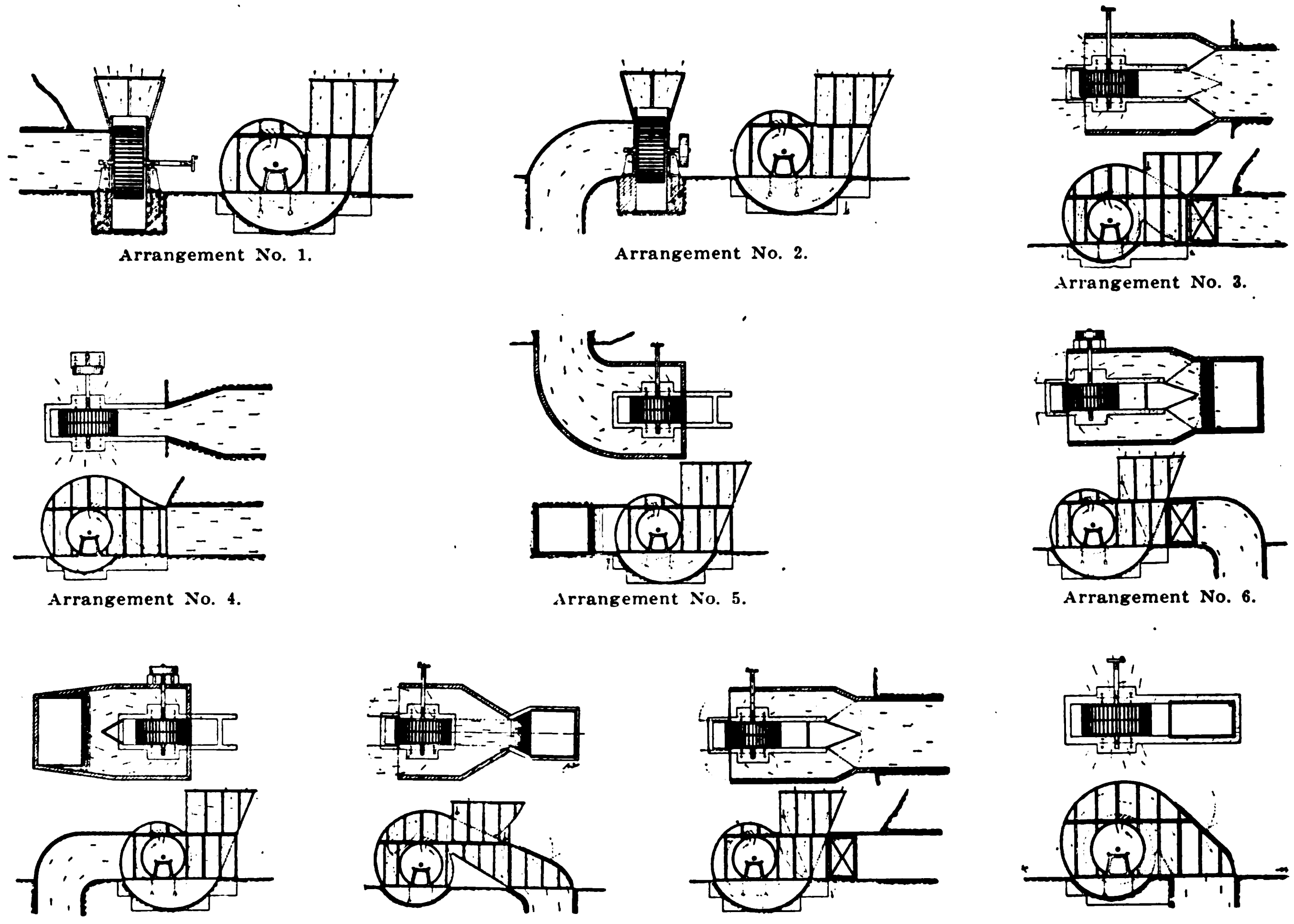
2. Double inlet exhausting, as shown in Arrangements 5 and 7.

3. Double inlet blowing, as shown in Arrangements 4 and 10.

4. Double inlet reversible, as shown in Arrangements 3, 6, 8 and 9.

Frequently the reversal of the ventilating system is referred to as "reversing the fan". This is an erroneous and misleading expression as the direction of rotation of the fan wheel remains the same, no matter whether running exhaust or blowing. It is solely the air current that is reversed, and this is done by closing and opening certain doors which control the entrance of air to the eye of the fan and its delivery either to the evase chimney or the fan drift. See arrangements 3, 6, 8 and 9.

In several of the arrangements shown, it will be noted that the fan is set in a direct line with the air course. This is not to be recommended since in the event of an explosion, the fan would be in the direct path of violence and likely to be badly damaged or totally destroyed. A better plan is to set it to the side. In addition to the protection thus gained, explosion doors may be provided which would be thrown open by the force of the blast and relieve the pressure before it reaches the fan. The presence of such doors is indicated in arrangements 8 and 10.



Arrangement No. 1.

Arrangement No. 2.

Arrangement No. 3.

Arrangement No. 4.

Arrangement No. 5.

Arrangement No. 6.

Arrangement No. 7.

Arrangement No. 8.

Arrangement No. 9.

Arrangement No. 10.

Fig. 36—General Arrangement of Fans.

Systems of Ventilation

The two systems of ventilation are the exhaust and the force, or blowing.

In the exhaust system, air from the mine is led from the top of the up-cast shaft, through the fan drift and side passages to the eye of the fan, and expelled by centrifugal action through the expanding chimney. In this system, the pressure of the air at any and all points within the mine is less than atmospheric pressure. The excess pressure of the atmosphere over the interior air produces a current in the down-cast shaft, which continues so long as the fan is in operation.

In the force system of ventilation the reverse is true. Air is brought to the eye of the fan through convenient doors, or openings, in the housing and on leaving at high velocity produces a pressure, or compression, on the entire column of air moving through the mine. In this system the interior air pressure at any and all points is greater than atmospheric pressure.

The relation borne by the ventilating pressure in each system to atmospheric pressure is an important one. It has considerable to do with the presence of gas in the workings under certain conditions. It is not at all likely that gas emanating from blowers is affected by the one system or the other, for the reason that the pressure back of the gas is so high that a slight force favoring or retarding its outflow would make no appreciable difference on the volume given off. Neither is it probable that occluded gas is affected one way or the other. But standing bodies of gas, as in abandoned sections, or the open spaces behind pillar workings, are, as we all know, very sensitive to changes of pressure. A fall of one-half inch barometer may produce from a large area an outflow of gas sufficient to make work hazardous, and enforce idleness, on one or more sections of the mine. This is because the decrease of air pressure against the body of gas allows it to expand, the excess flowing out into the workings.

Having a condition such as this, with the force system of ventilation it is possible to counteract the effect of this fall of pressure, due to atmospheric or natural causes, by increasing the speed of the fan, thus artificially producing a sufficient rise in pressure to maintain a normal interior pressure. Such a recourse is not possible with a fan running exhaust, unless it would be by slowing the fan, a proposition which, under the premises, could not be entertained.

This is, undoubtedly, a circumstance favorable to the force system of ventilation.

While fans and their driving mechanisms are generally so well constructed that accidental stoppages are few, yet this sometimes takes place and its effect should be understood. When a fan ceases running, there is no longer a motive power actuating the current. The almost instant effect of this is that the pressure within the mine becomes the same as that without, that is, it becomes equal to atmospheric pressure. Since, in the exhaust system, the normal mine pressure is less than atmospheric pressure, it follows that stoppage of the fan, with the consequent rise in pressure, increases the force against standing bodies of gas and hence tends to retard its outpouring. In the force system the reverse of this is true, that is, the pressure against the gas would be reduced to atmospheric pressure and thus favor its outflow.

In such a contingency the advantage lies with the exhaust system of ventilation.

With the exhaust system, the hoisting shaft, of necessity, becomes the down-cast. In the winter time, if the shaft is wet, trouble may be experienced in keeping ice from the guides or from accumulating on the wall plates and buntons in such quantities as to interfere with hoisting. This trouble would be met with mainly at night when the cages are at rest. An obvious remedy is to move the cages up and down on cold nights, say at hourly intervals. A method sometimes adopted is to run several lines of perforated pipes down the shaft and turn steam into these. The steam, escaping all along the length of the pipes, heats the cold air to a point above freezing.

An obstacle not so easily overcome, however, is the discomfiture to the cagers and helpers caused by the swift current of intensely cold air bearing continually upon them throughout the day. Where the quantity of air is large this becomes a positive hardship. With the blowing system these troubles are absent. The shaft landing is always comfortable at any season of the year, and the warm mine air, of course, removes entirely troubles due to ice. It is, however, possible for ice to form in the down-cast shaft, in fact, it was the almost total closure of the air shaft by ice that caused the Harwick, Pa., explosion, January 25, 1904, in which 178 lives were lost. Of late, however, it has become a common practice to turn exhaust and live steam into the down-cast when the fan is forcing the air, thus practically eliminating the chances for the formation of ice. This circumstance is, therefore, favorable to the force system.

At a shaft mine, where coal in the course of preparation is run over screens, a great quantity of fine dust is produced. In the exhaust system, the hoisting shaft being the down-cast, this dust is drawn directly into the mine and scattered along the haulage ways, and by this very fact adds to the possibility of an explosion. If the force system is used, the air supply is taken at a point removed from the tipple and hence a safer atmosphere is supplied.

This is an advantage of the force system.

A clearer understanding of the important part dust plays in the propagation of an explosion has had much to do with the choice of ventilating system. It has been plainly demonstrated that if dust is kept in a moist condition, its potency for harm is much reduced. A favorite method of accomplishing this has been to make use, in the cold winter months, of exhaust steam from the fan, pumps, hoisting engine, etc., or live steam from the boilers. Owing to the befogging of the air at the shaft bottom, it is, of course, impossible to turn steam into the hoisting shaft, as would be necessary provided the exhaust system were used. With the fan running as a blower, no inconvenience results in putting steam into the down-cast, since the fogginess is dissipated before the current starts on its return.

In this particular, favor lies with the force system.

An additional factor in determining the choice of systems is the use of electricity and the possibility of igniting a gaseous atmosphere by means of arching between the wire and the trolley wheel of the electric locomotive. In the exhaust system, the haulage ways are intakes, that is, they carry the pure and uncontaminated air into the workings. Locomotives in these intakes are operating under conditions favorable to safety, with respect to the ignition of gaseous mixtures. With the force system, the haulage ways carry the return air, which, in a gaseous mine, is likely to be dangerously charged with methane. A spark, under favoring conditions, might be all that is needed to ignite the gas and initiate a destructive explosion. It is because of such a possibility that many states prohibit the use of electric locomotives of the trolley pole type on return airways, provided the mine be gaseous.

This circumstance is favorable to the exhaust system.

A factor of slighter importance is that a fan exhausting requires a little more power than a fan blowing, in the ratio of the square of the air compressed by the latter, to the square of the pressure of the air expanded by the former.

ELECTRICALLY OPERATED FANS.

The power requirements of any type of fan is a function of the volume of air handled and the pressure or volume obtained. The pressure may be measured in ounces per square inch, but is often expressed in inches of water indicated by the water gage.

Using the following notation where:

P=pressure per square inch in ounces.

I=pressure in inches, water gage.

Q=cubic feet per minute.

K=a constant.

The relation between the pressure per square inch and water gage is shown by the formula:

$I=1.728P$, or $P=\frac{I}{1.728}$ With constant volume the power is directly proportioned to the pressure; with constant pressure the power is directly proportional to the volume handled per minute.

The general equation is, therefore, for centrifugal fans;

$$HP=\frac{K\times Q\times I}{33000\times Eff.}$$

where HP=Brake HP at fan shaft.

K=5.2 for centrifugal fans.

Eff.=Efficiency of fan expressed as a decimal and should be taken as 0.50 for plate and "Sirocco" fans and 0.45 for cone fans.

The following mathematical relations are theoretically true for all centrifugal fans and are used in most fans calculations:

Volume varies as the speed.

Pressure varies as the square of the speed.

Horsepower varies as the cube of the speed.

From the above it is seen that if a fan delivering 60,000 cubic feet of air at one ounce pressure when running at 124 RPM. requires 16 HP, the same fan at 248 RPM. will deliver 120,000 cubic feet of air at 4 ounces pressure and will require 128 HP, providing other conditions are the same.

In making recommendations for motors to be used for driving fans, it should be remembered that the name plate, size, or number of fan is but an indication of the power requirements and does not tell the conditions that have to be met with. The same fan will require many times as much power in some conditions of service as in others. If the volume and pressure are known, the application is a simple one, but for some purposes the only way in which the required volume and pressure can be satisfactorily determined is by trial. In the majority of cases the experience of the manufacturers enables them to predict the conditions and requirements with sufficient accuracy.

From the point of view of motor application, both the "Sirocco" and plate type have speed ranges that can be met by both D.C. and 25 and 60 cyc. A.C. motors of the usual standard number of poles, either by direct connection or by belting. For belt drive, it is usual to have the ratio of driven to driving pulleys not exceed 6 to 1 in order that satisfactory service be obtained.

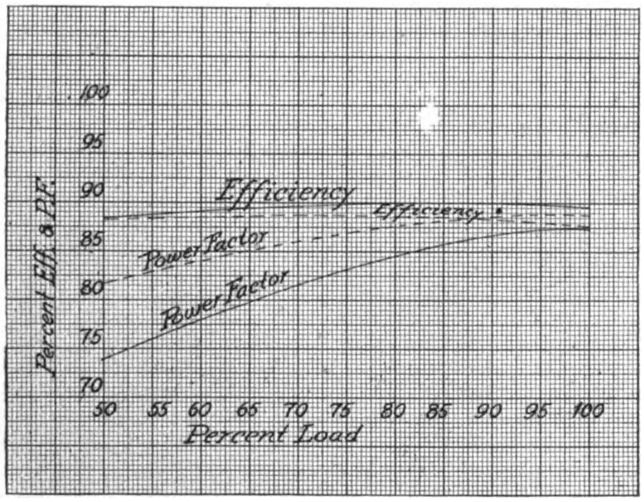
There are two type of A.C. motors usually employed to drive fans, the induction motor, and the synchronous motor. The 25 cyc. induction motors up to approximately 50 HP are built having standard speeds of 480, 725 and 1450 RPM. From 50 HP to 200 HP the most common speeds are 480 and 725 RPM. The 60 cyc. induction motors are built having speed as high as 3450 RPM on the smaller sizes; the standard 60 cyc. motor speeds for motors from 50 to 200 HP are 585, 700, 860, 1150 and 1750 RPM. The synchronous motor is not built in sizes smaller than 30 HP except in special cases. The speeds at which this type of motor can be obtained are much lower than those of the induction motor, due to the fact that the synchronous motor is inherently an A.C. generator, the speed of which is made to conform to moderately low speed reciprocating engines to which it is direct connected.

When contemplating the installation of a mine fan with motor drive, it is important to consider the available motor speeds that are more or less standardized for the particular HP required. In this way a considerable saving can be made in the first cost of the installation, for it is obvious that the slower the speed of a motor for a given HP output, the larger will be the frame and consequently the cost per horsepower. As high a speed motor as practicable should be used for belt drive, without exceeding a maximum safe belt speed. Belt speeds over 5500 ft. per minute should not be exceeded, if avoidable, and speeds between 3000 and 5000 ft. per minute are more satisfactory.

The question of the proper type of motor to be applied to a fan depends on whether constant or variable speed is desired. The torque characteristics of a fan are indicated in the preceding formula for horsepower, i. e., the torque varies approximately as the square of the speed. At half speed the torque is ¼ that at full speed. From the above it is seen that the size of inductions motor required to drive a fan is not determined by the amount of torque necessary to start it, because theoretically the starting torque is zero, except for that necessary to overcome the inertia and static friction, which in most cases is small. When applying a synchronous motor to a fan, however, the characteristics of this type of motor should be kept in mind. The self-starting synchronous motor usually pulls into step, or synchronism, at about 95 per cent of full speed and the torque developed at "pull-in" is usually between 35 and 45 per cent of full load torque. It is evident, then, that since the torque required by the fan is approximately 90 per cent of full load torque some means must be provided to close the fan inlet until the motor has pulled into synchronism. Some of the larger fans driven by synchronous motors are supplied with a clutch arrangement that permits the motor to be started and brought up to synchronism before the load is applied.

The principal advantage in using a synchronous motor is that it may be run at 100 per cent power factor, and when required, can be run at reduced power factor, leading, to compensate for lagging currents taken by induction motors driving breaker or tipple machinery. However, this advantage is minimized by the necessity of requiring an attendant to close and open the fan inlet when starting, after having been shut down due to failure of voltage or other causes. On the other hand, the induction motor or D.C. motor can be equipped with suitable control to start and bring the fan up to speed without the attention of anyone.

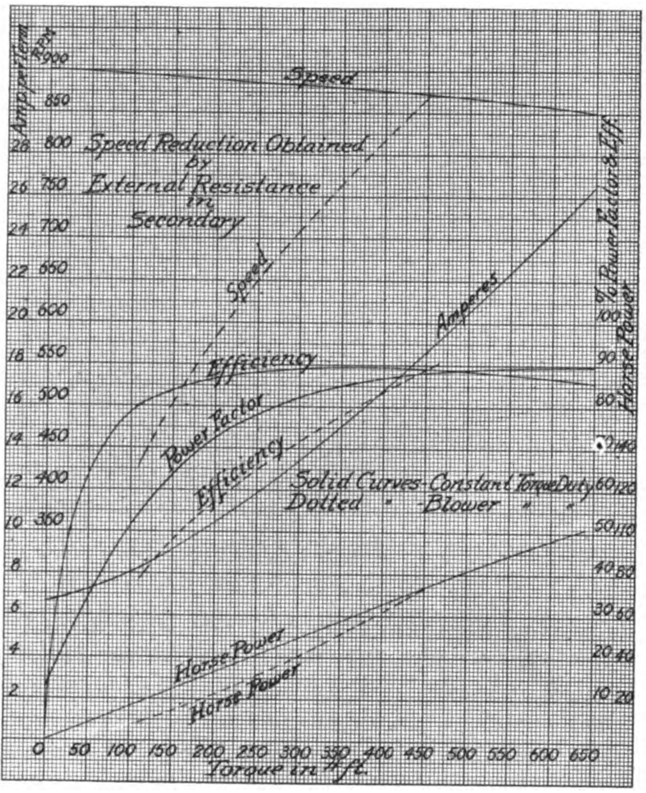
When the fan operates at the same speed 24 hours per day, the speed being changed at intervals of a few months, to take care of mine development, a simple arrangement is to belt a constant speed motor to the fan, and change pulleys when a change in speed is desired. The simplest type that can be used for this application is the A.C. polyphase squirrel cage motor. If, in this sort of application, the low power factor of the motor at light load is objectionable, a special motor with primary winding designed to give fairly high power factor at these loads can be supplied. This high power factor at light load is obtained at the expense of a slight decrease in the efficiency of the motor. However, if the fan is to be operated at a reduced capacity a large percentage of the time, the decrease in efficiency should be sacrificed in favor of the higher power factor. Figure 1 illustrates what can be accomplished by supplying a special winding to a standard squirrel cage motor to improve the power factor at light loads. The same effect can be accomplished by supplying reduced voltage taps from an auto transformer, so that the motor can be run at a lower voltage when lightly loaded.



Performance Curves of Squirrel Cage Induction Motor. Full Line Curves are for Standard Windings; Dotted Line Curves are for Special Windings.

Fig. 1.

When two definite speeds are required, these can be obtained by the two-speed squirrel cage motor if A.C. power is available, or by the use of the wound-rotor type of induction motor, the speed of which can be reduced to one-half by inserting resistance in the rotor circuit. The latter method is, of course, applicable where variable speed is desired. The first method of using a two-speed motor is obviously more economical from the point of view of efficiency than the resistance method, due to the two-speed induction motor having characteristics similar to those of the D.C. adjustable speed shunt motor, with shunt regulation, whereas the wound rotor motor, with resistance in the secondary, operates in a manner similar to a D.C. motor with resistance in series with the armature. Figure 2 shows the performance that might be expected from a 75 HP wound rotor induction motor, driving a fan at various speeds below synchronism, the speed reduction being obtained by inserting resistance in the rotor circuit. Figure 3 shows the relation of the performance of a two-speed squirrel motor at the two different speeds obtained by changing the grouping of the coils in each phase of the primary winding.

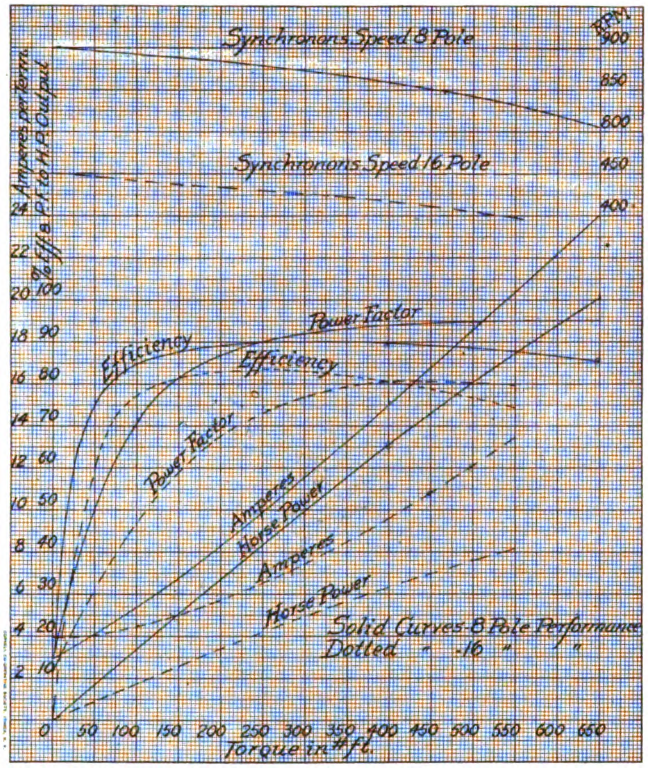


Comparison Curves Showing Performance of 75 H. P., 30, 60 or 2200 Volt. 8 Pole, Wound Rotary Induction Motor Under Constant Torque Driving Blower.

Fig. 2.

Both the wound rotor motor and the two-speed squirrel cage motors referred to are built on the same size frame, therefore, the cost of either motor is approximately the same. In the case of the wound rotor motor the grids necessary for speed reduction is an added cost, while with the two-speed squirrel cage motor no other auxiliaries are necessary in the control equipment, except a three-pole double throw knife switch.

Comparing the performance of the two classes of motors, when driving a fan, by reference to Fig. 2, it is seen that the wound rotor motor at half speed is delivering approximately 9½ HP with an efficiency of 39 per cent, the current and power factor being the same as if it were delivering 19 horsepower at full speed. Referring to Fig. 3, we find that the squirrel cage motor connected for 16-pole speed and running at approximately the same speed, or 445 RPM, delivers 9½ HP with an efficiency of 78 per cent and a power factor somewhat lower than the wound rotor motor. It is evident from the above comparison that the two-speed squirrel cage motor is more economical than the wound rotor motor, where two or more different speeds are required for long periods, but for several variations in speed over a wide range for short periods the wound rotor is the best adapted.



Comparison Curves Showing Performance of 75/25 H. P., 36, 60 or 2200 Volt 8/16 Squirrel Cage Induction Motor.

Fig. 3.

Several schemes have been tried out in Europe, and of late in this country, to give economical speed variation with A.C. power by the use of the three-phase commutator motor, and also a combination of wound rotor induction motor with low frequency synchronous converter and D.C. motor. While these schemes may be recommended and work out with a fair degree of success in Europe, their success in this country remains to be seen.

The fundamental fact that must be kept in mind when designing mine ventilating equipment is "Safety First," and in order to accomplish this, the designer, especially of the apparatus controlling the fan, must consider not only what control is the most economical, but what type of control is simplest. From the fact that continuity of service is an important factor, he must keep the number of parts likely to get out of order down to a minimum; he must consider the class of labor that is to operate the fan and make the control so simple, due regard given to other features, that in case of emergency any one with ordinary intelligence can operate it.

We are indebted to the following manufacturers for illustrations and assistance in the preparation of this article:

American Mine Door Co.
B. K. Elliott Co.
Bacharach Industrial Instrument Co.
Davis Instrument Manufacturing Co., Inc.
Ingersoll-Rand Co.
J. C. Stine Co.
Jeffrey Mfg. Co.
Morrow Manufacturing Co., The.
Scientific Materials Co.
Taylor Instrument Co.
Westinghouse Electric & Manufacturing Co.

AMERICAN BLOWER COMPANY

Detroit, Michigan, U. S. A.

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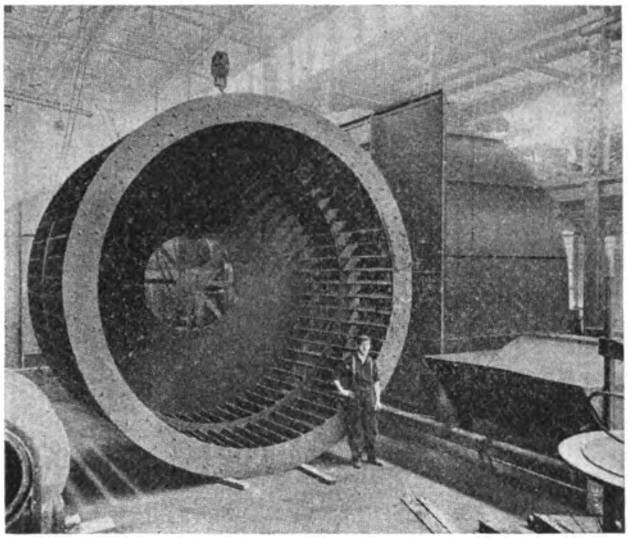
DENVER, COLO.
INDIANAPOLIS
KANSAS CITY
MINNEAPOLIS

Sirocco
TRADE MARK.

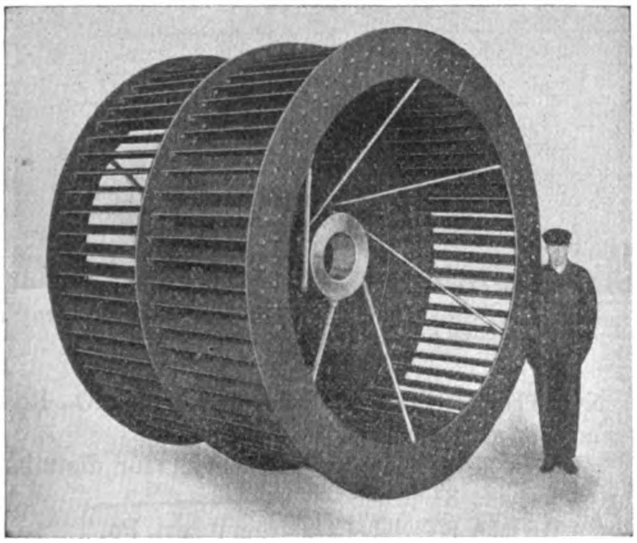
BRANCH OFFICES
NEW YORK
PHILADELPHIA
PITTSBURG
ROCHESTER, N. Y.
ST. LOUIS
SALT LAKE CITY
SEATTLE

Products

Mine Ventilating Fans; Mechanical Draft and Blast Equipment; Heating, Ventilating, Air Conditioning and Drying Apparatus; Vertical Enclosed Self-Oiling Engines; Detroit Systems for Handling Condensation.



Single Inlet "Sirocco" Fan Wheel in Course of Construction.



Double Inlet "Sirocco" Mine Fan Wheel.

The "SIROCCO" is the ORIGINAL fan of the many blade or turbine type. The description in the letters of patent is so carefully given that the imitators of the Sirocco Fan have not been able to put into their fans the distinguishing features that make the Sirocco the most efficient fan for mine ventilation.

THE INLET of the Sirocco Fan is from 25 to 100% larger than other types, because there are 64 narrow blades instead of fewer wide blades.

The air enters this inlet, which has a diameter almost equal to that of the fan itself, without whirling and consequently the blades act on air which is relatively at rest in regard to the motion of the blades instead of acting on air which is whirling in the same direction as the blades are moving.

Anyone can easily appreciate the increase which this will make in the amount of air forced out from between the revolving blades.

THESE 64 BLADES are inclined forward in the direction of rotation. The narowness and peculiar angle of the blades greatly improve the stream lines of air leaving the fan. The air leaves the blades and travels forward in the same path as the air which has just preceded it. In other words, the air is not thrown off at one hundred different angles causing eddies and cross currents and thus absorbing valuable energy in overcoming them and driving the air forward.

The blades are mounted on a heavy steel disc, which, in turn, is fastened to a heavy cast iron hub, accurately bored and key-seated to receive the shaft. The outer annular ring is reinforced with heavy tie rods of drop forged carbon steel, so arranged as to form a bracing unexcelled for strength, but which does not obstruct the free inflow of air.

The SHAFTS are forged steel, ground to size.

The BEARINGS in the smaller sizes are self-aligning, in the larger sizes rigid, with provision for lateral and vertical adjustment. All are double ring oiling and lined with our special babbitt metal.

The HOUSINGS are built of the best quality leveled steel plate, heavily stiffened, and are provided with adjustable inlet cones. This permits the wheel being removed without dismantling the housing, and further reduces inlet losses.

"SIROCCO" Fans have the highest volumetric, manometric, and mechanical efficiencies of any fan on the market.

The great capacity of "Sirocco" Fans enables the use of smaller diameter wheels, whereby smaller foundations are required, with MARKED SAVING IN INSTALLATION COST.

LOW TIP SPEEDS mean long life.

HIGH MECHANICAL EFFICIENCY means low power requirements and economy of operation. The saving in cost of operation will pay for the fan in a short time. If you are using other types of fans, "power eaters," it will pay you to scrap them and install "SIROCCO." If you are in the market for new equipment you will be money ahead if you install a "SIROCCO," even if you could get another without cost.

THE MOST DISCRIMINATING USERS, not only in mine work, but in all the other fields requiring fans or blowers, have selected the "SIROCCO" fan as a standard. Included in this class are many large corporations, and leading engineers and architects throughout the country. A list of users will be gladly furnished on application.

"SIROCCO" Fans can be furnished in all the usual arrangements, for exhausting or blowing, reversible or not, and arranged for belt, rope, chain or geared drive, or for direct connection to engine or motor.

Inquiries should be as explicit as possible, with detailed information as to the conditions. Let our corps of skilled engineers give you the benefit of our experience, to your ultimate profit.

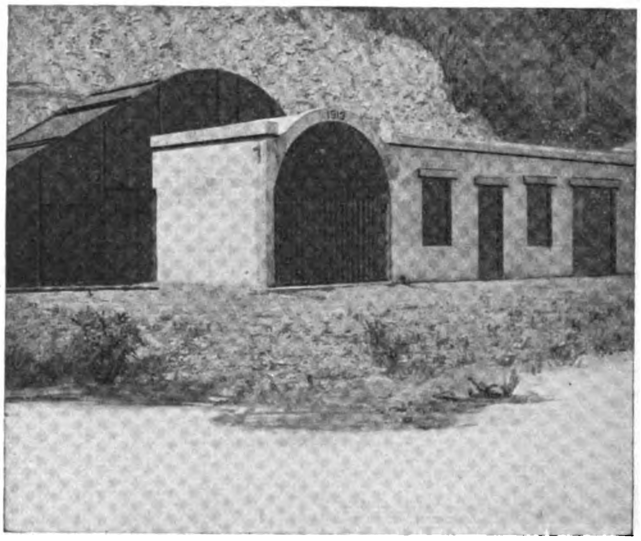
Some Important Users of "Sirocco" Fans:

ANACONDA COPPER MINING CO., Butte, Mont., 97 fans at various mines.

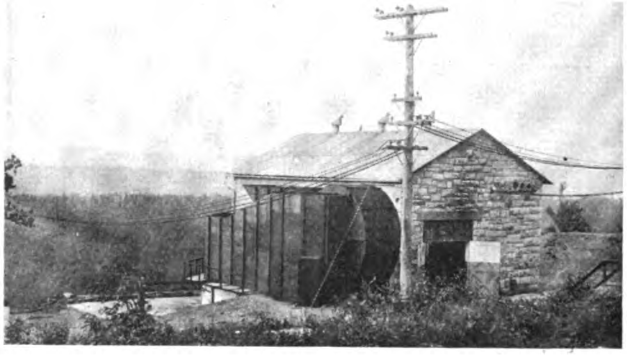
POND CREEK COAL CO., Williamson, W. Va., and U. S. COAL & OIL Co., Holden and Monaville, W. Va., 11 fans.

PITTSBURGH COAL CO., 5 fans at various mines in Pennsylvania.

Crescent Mine of Pittsburgh Coal Co.



One of 2 "Sirocco" Fans at United States Coal & Oil Co., at Holden, W. Va.



Sirocco Mine Ventilating Fan at Black Rock Mine, Shaft No. 4, of the Lehigh Coal & Navigation Co., Lansford, Pa.

NORTHWESTERN IMPROVEMENT CO., Roslyn and Tacoma, Wash., 4 fans.

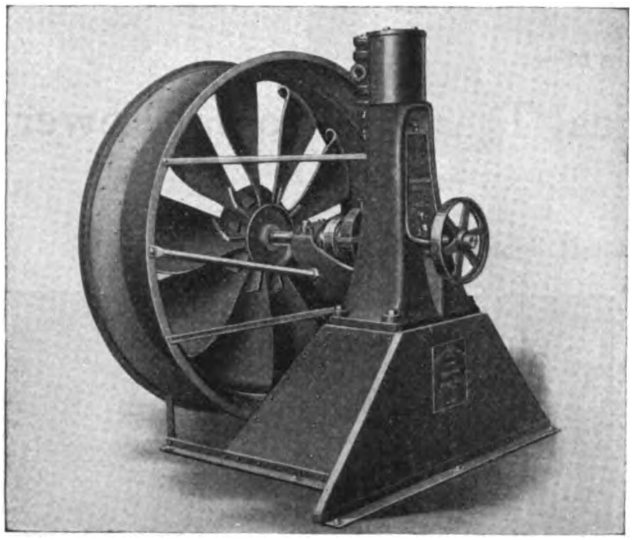
MITSUI & CO., New York City, (for distribution in Japan) 31 fans.

CAMBRIA STEEL CO., Johnstown, Pa.

And many others.

Ventura Disc Mine Fans

THE VENTURA DISC MINE FAN is especially adapted to the ventilation of DRIFT MINES and for DEVELOPMENT WORK on new operations where the requirements do not exceed the quantities given in the following capacity table.



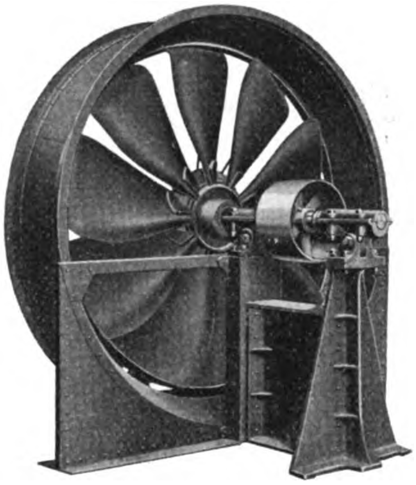
The fan is of EXTRA HEAVY CONSTRUCTION, having ten die-formed curved blades, in the larger sizes reinforced. A large cone-shaped central disc prevents any back draft. The shafts are extra heavy, ground to size.

The BEARINGS are double ring oiling adjustable, lined with our Special Babbitt, and are mounted on heavy cast iron pedestal. THIS BRINGS THE BEARINGS OUTSIDE THE DRIFT, WHERE THEY ARE EASILY ACCESSIBLE.

In addition to the regular line of pulley fans, it can be furnished with direct connected engines or motors to suit the usual electric currents encountered.

General Data

DIAMETER OF WHEEL	LIST PRICE	PULLEY		DIAMETER OVER ALL	DIAMETER OF SHAFT	WIDTH OF CASE	SHIPPING WEIGHT IN POUNDS	TELEGRAPHIC CODE WORD
		DIAMETER	FACE					
48	$185	13	5¼	58	1 11/16	15¾	750	Mealy
54	205	14	6¼	65	1 15/16	17½	850	Meander
60	295	16	6¼	72	2 3/16	19½	1200	Meandry
● 66	330	16	7¼	79	2 7/16	21½	1400	Mease
72	370	18	8	85	2 11/16	24	1600	Meated
84	550	20	9	101	2 15/16	27	2100	Meatus
96	750	24	10	107	3 7/16	31½	2600	Meawl



CAPACITY TABLE FOR MINE VENTILATION FOR ALTITUDES UP TO 1000 FEET

DIAMETER OF WHEEL INCHES	¼″ PRESSURE			⅜″ PRESSURE			½″ PRESSURE			⅝″ PRESSURE		
	CU. FT. MIN.	R.P.M	B.H.P.	CU. FT. MIN.	R.P.M	B.H.P.	CU. FT. MIN.	R.P.M	B.H.P.	CU. FT. MIN.	R.P.M	B.H.P.
48	12,550	424	0.97	15,320	518	1.77	17,770	598	2.73	19,870	670	3.82
54	15,800	376	1.22	19,300	460	2.22	22,380	532	3.43	25,000	594	4.8
60	19,400	338	1.49	23,750	414	2.73	27,500	478	4.22	30,700	535	5.9
66	23,400	308	1.80	28,550	377	3.28	33,100	436	5.06	37,000	488	7.12
72	27,800	282	2.14	34,000	345	3.92	39,400	398	6.05	44,000	446	8.48
84	37,750	241	2.9	46,100	296	5.3	53,500	342	8.2	59,750	382	11.5
96	49,000	211	3.76	60,000	259	6.91	69,500	299	10.7	77,650	335	14.9

DIAMETER OF WHEEL INCHES	¾″ PRESSURE			1″ PRESSURE			1¼″ PRESSURE		
	CU. FT. MIN.	R.P.M	B.H.P.	CU. FT. MIN.	R.P.M	B.H.P.	CU. FT. MIN.	R.P.M	B.H.P.
48	21,700	731	5.0	25,100	846	7.71	28,000	946	10.75
54	27,340	650	6.3	31,600	751	9.7	35,300	840	13.55
60	33,600	584	7.74	38,800	676	11.9	43,450	755	16.7
66	40,400	533	9.3	46,700	615	14.35	52,200	688	20.1
72	48,150	488	11.1	55,600	564	17.1	62,250	630	23.9
84	65,350	418	15.0	75,500	483	23.2	84,300	541	32.4
96	85,000	366	19.6	98,000	423	30.1	109,820	473	42.1

The pressures at the top of the columns are static pressures in inches of water.

Under the conditions assumed in making up this table, the capacities given, are guaranteed to be correct. At any of the above speeds, the volume of air delivered will be less, if the resistance is more than has been assumed, in which case the resulting pressure will be higher and the horse power required greater.

DODGE SALES & ENGINEERING CO.

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Builders of

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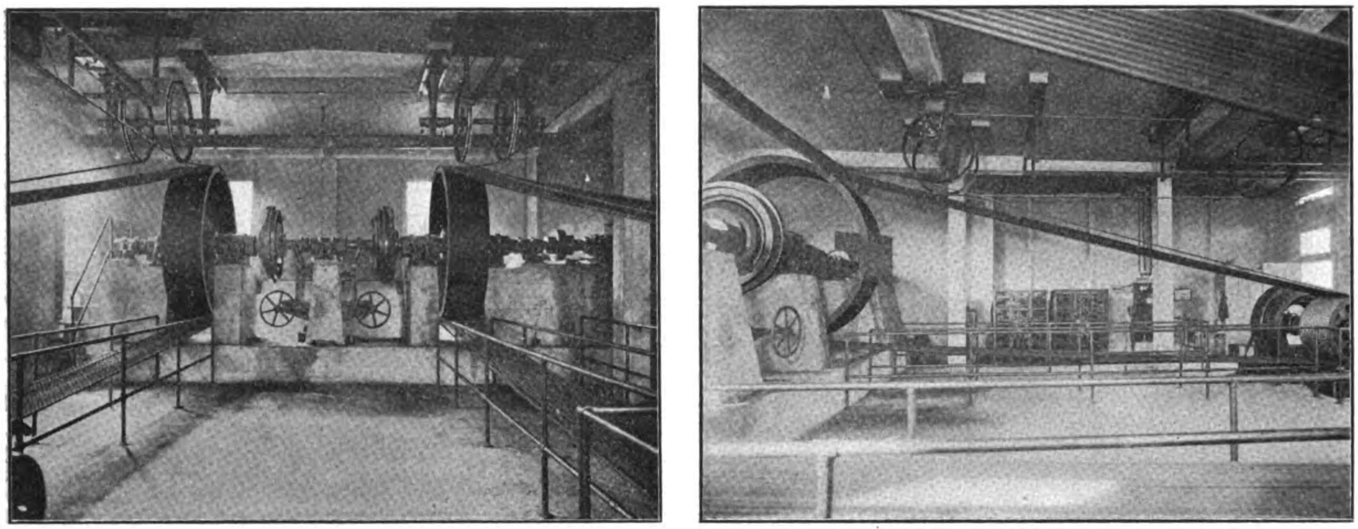


Rope Driven Ventilating Fans installed in the Monongahela River Consolidated Coal & Coke Company's Crescent Mine near California, Washington County, Pennsylvania.

The pre-eminent ideas governing the design of the ventilating equipment of the Monongahela River Consolidated Coal & Coke Co.'s Crescent Mine, located near California, Washington County, Penna., were to provide against interruption of service, and to secure a permanent, fire-proof construction that would endure throughout the life of the mine, combined with the highest possible efficiency of the fan.

The desirability of continuous operation is easily appreciated, and, in emphasis of the importance of permanent construction, it may be said that with an output of 6000 tons daily the estimated life of this mine is 35 years.

Cost of power is apparently often disregarded or passed over with the thought that the generation of a few horse-power will show no appreciable increase in the expense of operation, but the fact remains that every horse-power generated represents an expenditure of money.

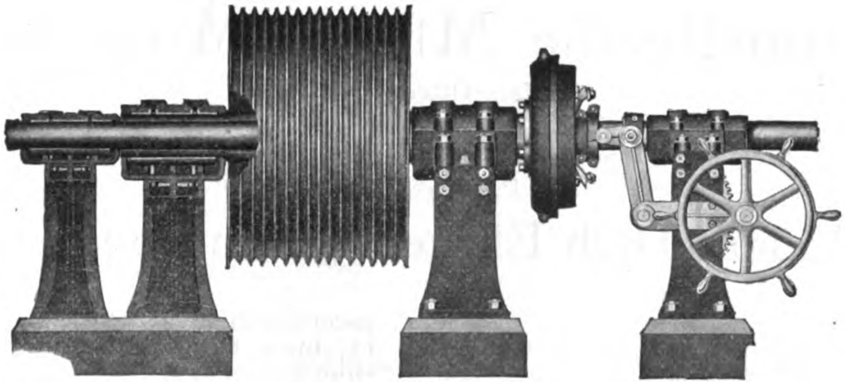
In the case of this installation each per cent. increase in efficiency means a saving of approximately four horse-power, or say $400 annually; an amount justifying a considerable outlay, tending to increase the efficiency.

For the fulfillment of the above conditions, several innovations were employed. Chief among these may be mentioned the duplication of the fan-driving machinery.

Power Transmission to the Fan

The fan is driven by Dodge rope transmission from two 300-hp., 450-r.p.m., 2300-volt, 60-cycle, three-phase-wound motor, variable-speed, induction motors.

To provide for increased ventilation in an emergency, the rope sheaves are proportioned to operate the fan at normal speed with a motor speed of 400 r.p.m., so that full motor speed would run the fan at 172 r.p.m., or ten per cent. above normal.



Single Quill Installation showing Dodge Self-Oiling Bearings and Dodge Split Friction Clutch.

The rope transmission are the Dodge Manufacturing Co.'s American or single rope system, each carrying sixteen wraps of 1-in. manila rope, and are duplicates in every particular.

The motor sheaves are 42 in., and the driven sheaves 107 in. in diameter. These latter are mounted on hollow or quill shafts through which a 7-in. jack shaft passes. The jack shaft is rigidly connected to the fan axle with a flanged coupling and is engaged by 48-in. Dodge split friction clutches bolted to flanges on the ends of the quill shafts and operated by handwheel and pinion.

The quill and jack shafts are supported indepently in Dodge adjustable Self-oiling Bearings, resting on concrete pedestals, which are joined by a continuous concrete footing to prevent uneven settling.

The motors are set 30 ft. centers from the jack shaft, which gives sufficient room to operate the tension carriages inside the building. The winding sheaves and tension carriage tracks are placed directly above the driving ropes, and are bolted to timbers, which are in turn secured by anchor bolts to concrete leveling pads on the under side of the roof.

With this arrangement extreme accuracy in setting the anchor bolts is avoided and the alignment of sheaves and tracks greatly facilitated.

Either drive can be thrown in or out without changing the speed of the fan, in fact the sheaves and clutches on the quill shafts being split, one drive could be dismantled without interfering with the operation of the other.

The ropes run exceedingly smooth and are practically noiseless, and in addition when worn out their replacement is a matter of small expense.

The foregoing description of a rope drive fan installation contains a suggestion that should be welcomed by every progressive mine owner or operator.

The dependability of rope-driven apparatus; the low cost of upkeep; the ability to use either one or both drives; are arguments for non-stop economical operation that cannot be ignored.

Forcibly, too, the argument comes home to the man who considers this equipment, that the twin drives with quill and clutches complete will cost approximately the same as would a first-class belt drive using a good grade of leather belt.

In the belt drive the belt would constitute the major expense of installation, while in the rope drive the rope is the minor consideration; just so in the belt drive the wear comes on that part of the equipment which costs the most to renew, while in the rope drive the wear is absorbed by the least expensive unit, the rope.

Surely this whole matter is worthy of the consideration of those who seek high efficiency, uninterrupted service, and low cost of upkeep.

Dodge Self-Oiling Adjustable Pillow Block.

Dodge Engineers are always at your disposal. Their services cost you nothing; the value of their advice is not measured in dollars and cents, but as you recognize their efforts as being solely in your interest and for your profit.

The Connellsville Mfg. & Mine Supply Co.

Main Office and Works
CONNELLSVILLE, PA.
Birmingham, Ala., Brown-Marx Building
The Pioneers and Leaders in

Modern High Efficiency Fan Construction

Connellsville Fans

We build nearly every conceivable style of Fan so far as their construction, housings and settings are concerned; in Blowing, Exhaust and Reversible; for engine or motor drive; in sizes from 5 ft. to 35 ft. diameter, and widths to suit conditions.

Every Fan is designed as a unit proposition, after having taken all of the known Engineering data and mining conditions into account.

Large Diameter Fans

Mine resistance, or the friction of the air in passing through the entries, is measured in inches of water gauge, and it is a well known fact that a fan, to produce a high water gauge, must run at a high rim speed to sustain it. It is also a fact that under given conditions a smaller diameter fan will produce a higher volumetric ratio of delivery than a large one, and for this reason it is possible to get as much air and as high a water gauge with, say a 12- or 14-foot fan running at a high rotative speed, as can be had with a 20-foot fan running at a normal and safe speed.

It is also a fact that there is less danger involved in running a larger diameter fan up to a given rim speed than in the smaller fan, and maintenance and repair costs are less. We believe that it has been demonstrated that the saving of power and operating cost in a large fan in a few years will more than offset the difference in initial cost over that of the smaller fan.

Our Proven Records

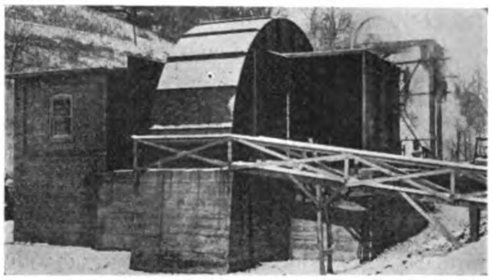
Volume Record—675,000 cu. ft. of air per minute on 10.3″ of water gauge at 100 R. P. M.

Efficiency Record—87.2% overall for Fan and Drive on 359 H. P. input and 8293 ft. periphery speed of the wheel.

No. 7 cut shows our improved, split, clamped hub spider construction, which spells:—"No More Loose Spiders or Spider Troubles."

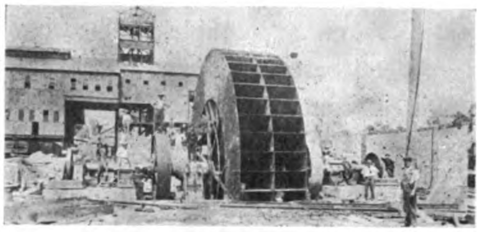
Nos. 8 and 9 show our improved, double hinged, reversing doors; designed and introduced in 1901, patented in 1903; which make it possible and easy to obtain the same efficiency in a reversible Fan running either way.

Nos. 10 and 11 show two of our representative types of Fans.



No. 10.

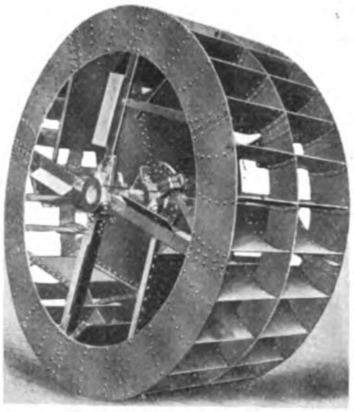
We hold and own four (4) U. S. patents that cover the various original characteristics of this Fan, which is the embodiment of all of the safest and best principles of Fan construction, as well as those which promote the highest degree of efficiency.



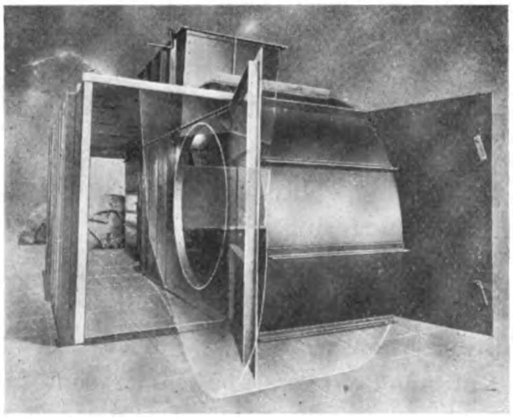
No. 11.

This is the "PIONEER" and all others that possess its appearance and features are copies and infringements.

If you will submit your ventilating problems to us, you will receive prompt attention and if you trust us with your business, you can rely on getting satisfying service.



No. 7—1911



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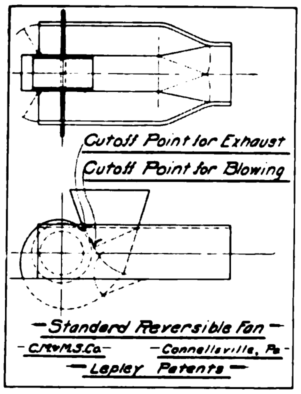

No. 9—1901-03

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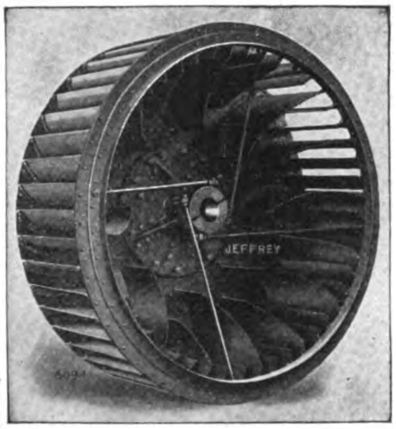
Philadelphia	Real Estate Trust Bldg.
Pittsburgh	Farmers Bank Bldg.
Scranton, Pa.	Union Nat. Bank Bldg.
Broadwell, O.	H. H. Townsend
Middlesboro, Ky.	Middlesboro Hotel
Charleston	West Virginia
Cleveland	421-423 Rockefeller Bldg.
Chicago	McCormick Bldg.
St. Louis	Railway Exchange Bldg.
Milwaukee	M. & M. Bldg.
Denver	First National Bank Bldg.
Seattle	L. C. Smith Bldg.
Birmingham	Brown-Marx Bldg.
Dallas	Commonwealth Nat. Bank Bldg.
Canadian Works	Montreal

Jeffrey Stepped Multi-Bladed Mine Ventilation Fans

are built to handle the air at low velocities.

The Jeffrey Multi-Bladed Fan Wheel

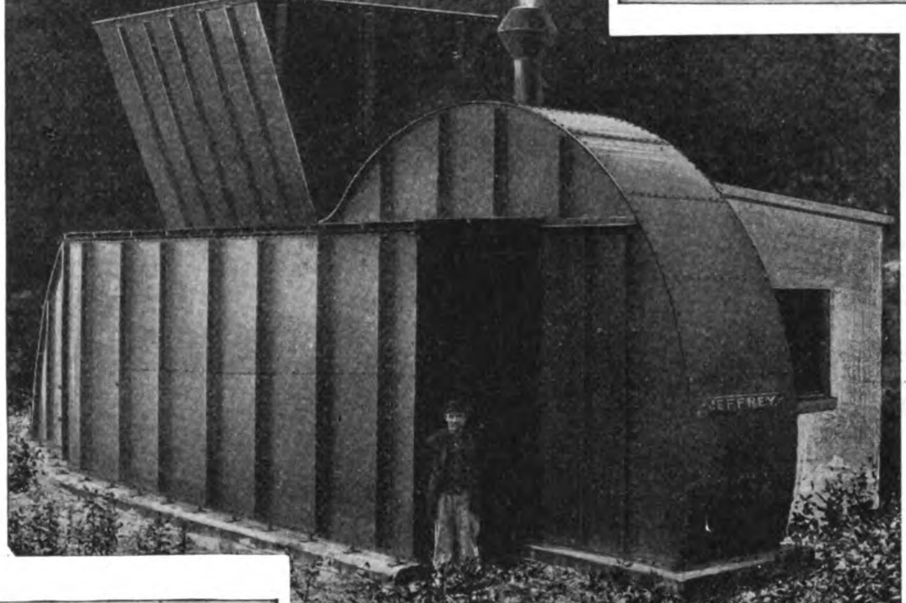
with its stepped series of blades receives the air at a low velocity and accelerates it without shock, which means the maximum of economy in operation.



Single Inlet Stepped Multi-Bladed Fan Wheel

Your interests can be best served by a concern whose fans are designed for one purpose only—the ventilation of mines.

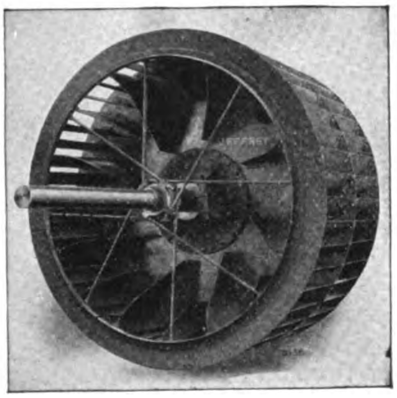
Carefully consider that the Jeffrey Stepped Multi-Bladed Fan requires less power for its operation than any other fan heretofore offered.



Complete Steel Casing

extending to the ground line saves masonry work and reduces cost of installation to a minimum.

We adapt our fan casings to meet any conditions and provide explosion doors for same.



Double Inlet Stepped Multi-Bladed Fan Wheel

We build the Most Complete Line of Fans for the Ventilation of Mines made by any manufacturer in the World.

Jeffrey Centrifugal Fans

are built in sizes from 2 ft. to 20 ft. with capacities from 10,000 to 600,000 cubic feet per minute.

We also build Centrifugal Booster Fans and a complete line of Disc Fans.

Write for "Jeffrey Mine Ventilation Catalog," the most complete ever published.

The illustrations on the opposite page will give a comprehensive idea of the designs best adapted to any particular installation. These illustrations cover the majority of standard designs, yet there are some locations where a different arrangement is required, and estimates covering same will be furnished upon request.

The fans are built for direct connection to an engine and in the small sizes they can be direct coupled to a heavy slow speed motor. They are also arranged for belt drive from a motor or an engine, and where space is limited a silent chain drive may be used on the smaller fans.

THE JEFFREY MANUFACTURING COMPANY

Useful Information for Selecting a Jeffrey Mine Fan

Volume.	Water Gauge.	B. H. P.	Double Inlet Fans.	R. P. M.	Volume.	Water Gauge.	B. H. P.	Double Inlet Fans.	R. P. M.
6000	¼"	½	2'x18"	260	100000	1"	22	10'x4'	100
8000	½"	1		367	123000	1½"	42		123
10000	¾"	1.8		448	141000	2"	62		141
12000	1"	3		520	173000	3"	115		173
15000	1½"	5.5		633	200000	4"	178		200
17000	½"	2	3'x2'	244	125000	1"	28	12'x4'	84
21000	¾"	4		300	177000	2"	79		119
24000	1"	6		346	218000	3"	145		146
30000	1½"	11		423	250000	4"	222		168
34000	2"	17		487	280000	5"	311		188
25000	½"	3	4'x2'6"	183	150000	1"	33	14'x5'	70
31000	¾"	6		224	214000	2"	95		100
36000	1"	9		259	261000	3"	174		122
44000	1½"	17		317	300000	4"	267		140
50000	2"	25		366	338000	5"	376		158
35000	½"	5	5'x3'	146	175000	1"	39	16'x5'	63
43000	¾"	8		179	245000	2"	109		88
50000	1"	13		207	300000	3"	200		108
60000	1½"	23		254	350000	4"	311		126
70000	2"	35		292	386000	5"	430		139
50000	½"	7	6'x3'	122	283000	2"	125	18'x6'	79
70000	1"	18		172	344000	3"	230		96
86000	1½"	32		211	400000	4"	355		112
100000	2"	50		244	443000	5"	492		124
120000	3"	90		294					
75000	¾"	14	8'x3'6"	108	315000	2"	140	20'x6'	70
91000	1"	23		124	380000	3"	250		85
106000	1½"	40		152	450000	4"	400		100
129000	2"	65		176	495000	5"	550		110
150000	3"	112		215					

The above table was compiled to give the Mine Superintendent, Manager or those interested in this line of work a comprehensive idea of the results obtained from various sizes of Jeffrey Mine Fans.

It is understood that the widths of the Fans may be changed to meet other conditions; that is, a Fan may be built wider to economically handle a larger volume of air at the same gauge, or on the other hand the Fan may be built narrower to handle a smaller volume at the same gauge while the speed of the Fan remains constant.

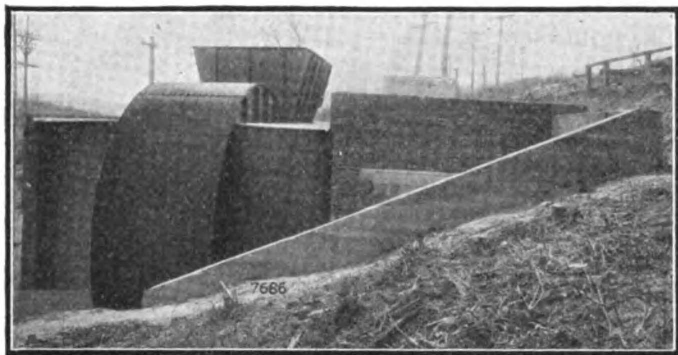
The Fans are built for direct connection to an engine and in the small sizes they may be direct coupled to a heavy slow speed motor. They are also arranged for belt drive from a motor or an engine and where space is limited a silent chain drive may be used on the smaller Fans.

In asking for prices on Fans it is essential to give all information possible, and in many cases it is advisable to have one of our experts take up the problem at the Mine and determine the Fan best adapted for your particular requirements and submit plans and specifications for your consideration.

It will pay you to investigate our Centrifugal Booster Fans. They have saved operators thousands of dollars cleaning up old air ways. Built with capacities from 10,000 cu. ft. to 70,000 cu. ft.

The Jeffrey Propeller Fan is a distinct improvement over anything which has heretofore appeared. It embodies new features; it is self contained and is fitted with ball bearing thrust collars placed on each side of the wheel. Simple in operation, easily installed and reversed by simply changing direction of rotation.

Jeffrey Mine Fan Installations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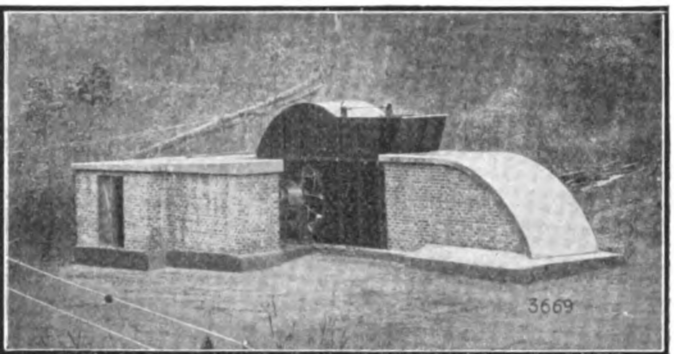
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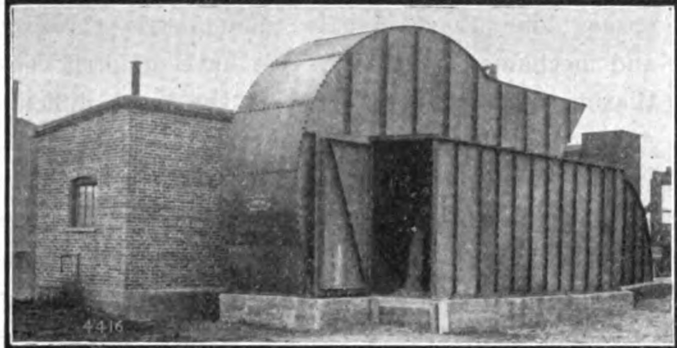
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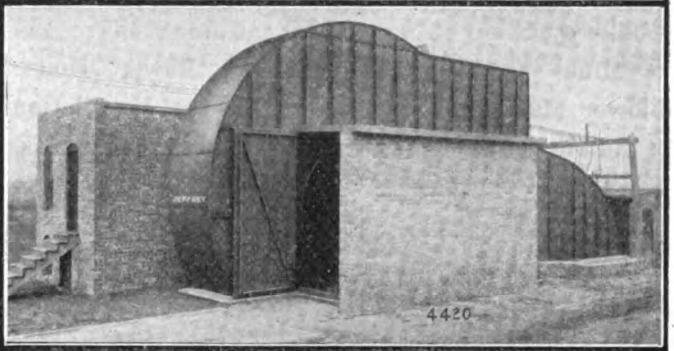
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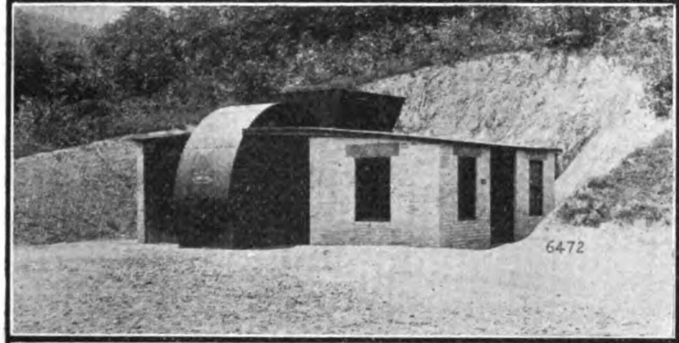
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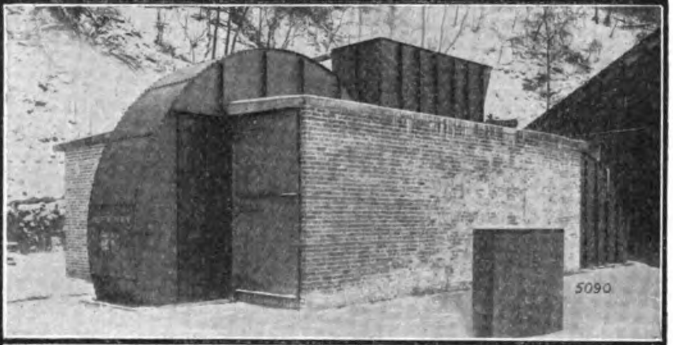
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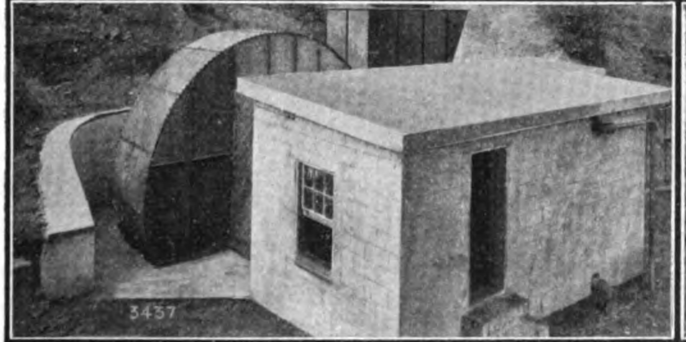
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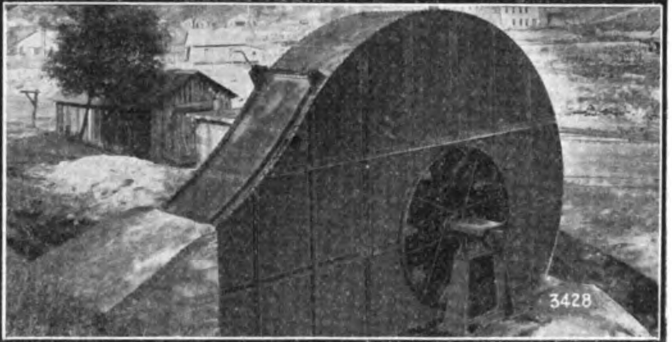
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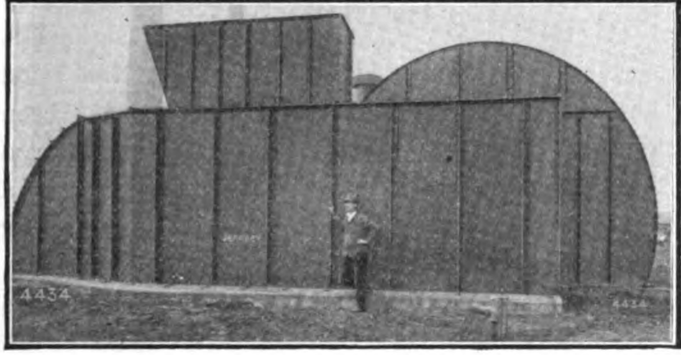
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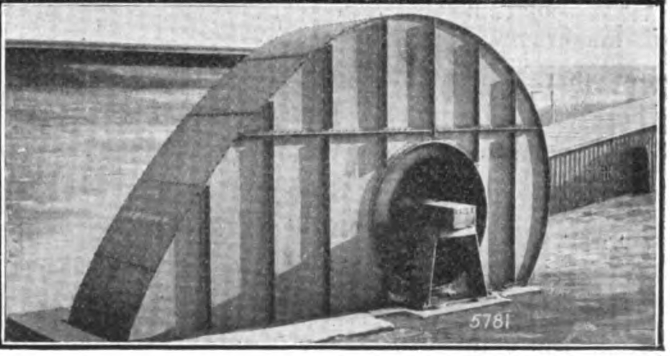

5781

ROBINSON VENTILATING CO.

Successor to J. R. ROBINSON

8044-5 JENKINS ARCADE BUILDING

PITTSBURGH, PENNA.

Products

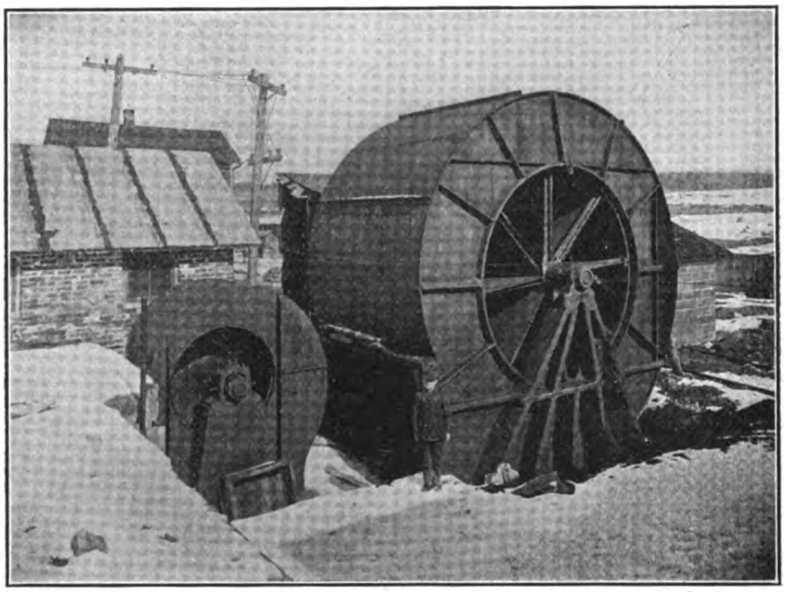
Mine Ventilating Machinery, Power House Blower Machinery, Machinery for the Ventilation of Buildings, and High Pressure Fans for Cupolas, Forges and Furnaces.

Robinson Fans

Robinson Fans are the latest development in fans, for mines, power houses, cupolas or for any purpose where economy of space or power is worth considering.

These fans are the result of careful designing and long years of experience.

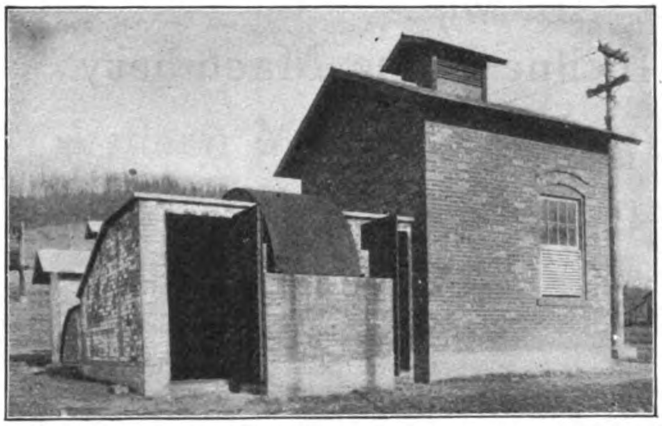
Every mine requires ventilating apparatus especially adapted to it. A large part of our business consists of the replacement of machinery and equipment where mistakes have been made—where the machinery has been found to be wasteful and inefficient. We have been able to save from 10 to 60 per cent. of the power consumed by the fans replaced. The reason for this is that the years of study and experiment which we have carried on in this field have resulted in our designs being unequalled in point of economy of power, economy of space, volumetric capacity, manometric capacity and mechanical efficiency. We have adapted ventilating machinery to some of the most difficult mines in the country, under all conditions of service. Installations engineered by us have been most economical as to first cost, maintenance and the use of power. Our experience and engineering knowledge are at your service. You cannot buy a better fan than the Robinson Turbine Fan. And when we install a fan in your mine it will be one to exactly fit the necessities of that mine.



Cut No. 1

Cut No. 1 shows two fans at the Winburne Mine of the Pennsylvania Coal & Coke Company, Winburne, Pa. The large fan is one of the old Robinson type, made 15 years ago, and is operated by a steam engine. A special boiler was required for this fan, and an attendant night and day. The fan has been replaced by a modern Robinson Turbine Fan, driven by electric motor. The power is purchased from a public service corporation. The small fan is doing the same work that the large fan did, and is saving, through the purchased power, the wages of two attendants.

Cut No. 2 shows one of two Robinson Turbine fans, replacing two 14-foot fans at the mines of the Clearfield Bituminous Coal Corp., at Rossiter, Pa. The new machines are each 5 feet 3 inches in diameter and are direct connected to 100-H. P. 250-volt alternating current motors. The two machines ventilate four mines, each forcing about 100,000 cubic feet of air per minute against a 3-inch water gage.



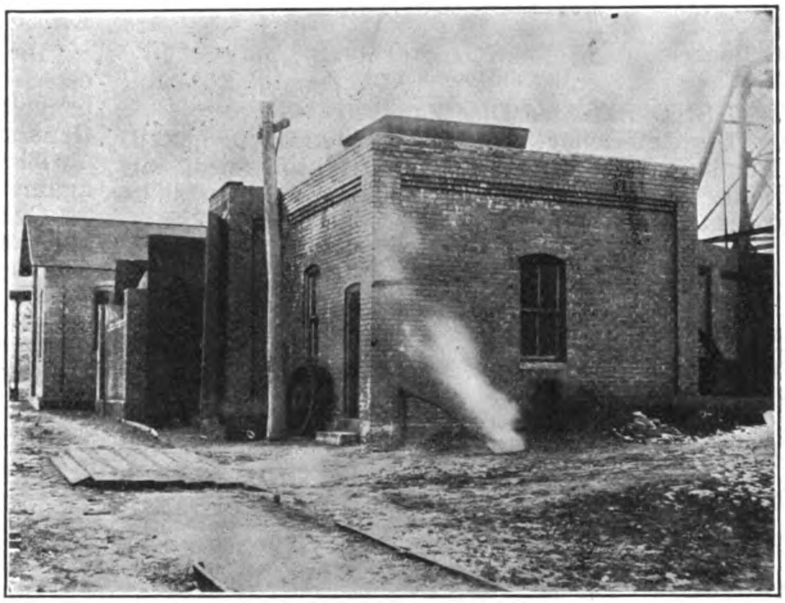
Cut No. 2.

The substitution of these new fans resulted in many savings, chief among which is 22 tons of coal a day. In making the calculations for the installation of this equipment, the value of the fuel required was figured at $1.20 per ton, which was about the average price such fuel was bringing at the mine at that time. At this price, it was calculated that the installation would pay for itself in about 15 months. At the prices of coal now prevailing the saving of coal would be sufficient to pay for the entire installation of fans, housings, motors, etc., in less than 60 days.

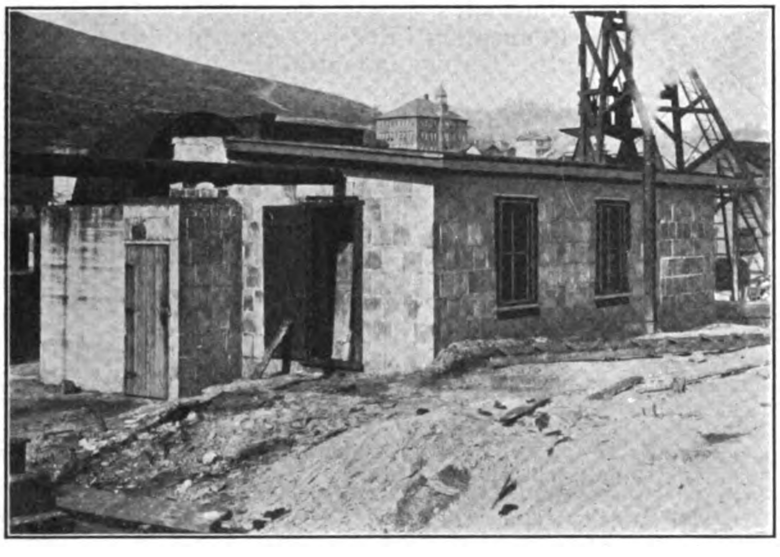
Added to the high saving in coal, there is the decrease in operating costs, such as labor. The plant has been in successful and satisfactory operation somewhat over a year, and the owner is contemplating the installation of a similar plant at another mine.

Illustration No. 3 shows the remodled fan house which gives the Federal Coal & Coke Co. two independent ventilating units, either one of which can be used as desired at a minute's notice in case one of the units requires repairs or attention, it can be shut down. With this equipment it makes this company sure of efficient ventillation at all times under all conditions.

Cut No. 4 shows a fan at the Newburg Shaft of Virginia-Maryland Coal Corporation, Newburg, W. Va. The Newburg Shaft is a high pressure mine and an error was made in installing a low pressure fan. The Robinson fan shown in the cut replaced this low pressure fan, and produces the required air with a great saving of power. The Robinson fan is 5′ 3″ diameter and is operated by a 150 H. P. steam engine. The fan displaced was one of the best modern steel fans 16′ in diameter with a 400 H. P. engine. It was able to produce only 70% of the volume of air that the Robinson fan is producing.



Cut No. 3.



Cut No. 4.

The ventilation of mines is an engineering proposition, and these four illustrations show the benefits accruing to the owners of mines who employ expert ventilation engineers to make the fan installations.

THE J. C. STINE COMPANY

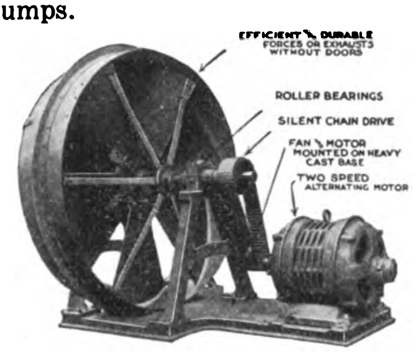
TYRONE, PA.

Manufacturers of

Mine Fans, Pumps and Incline Plane Machinery

Products

Disc Fans, Centrifugal Fans, Incline Plane Machinery and Sheaves of all dimensions, Electric Driven Pumps.

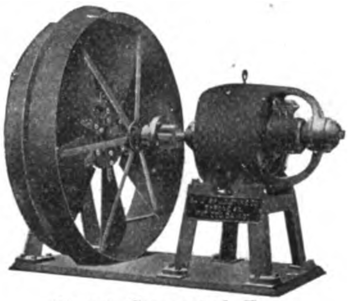

EFFICIENT & DURABLE
FORCES OR EXHAUSTS WITHOUT DOORS
ROLLER BEARINGS
SILENT CHAIN DRIVE
FAN & MOTOR MOUNTED ON HEAVY CAST BASE
TWO SPEED ALTERNATING MOTOR

Chain Driven Type.

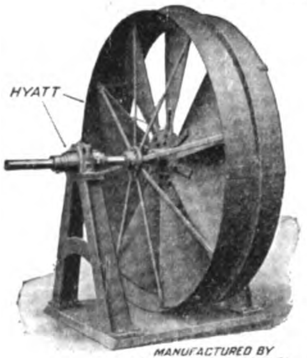
J. C. Stine Patented Disc Fans

High efficiency, low first cost, cheap to install. Hundreds in service. The most economical fan built. Noted for its durability. Exhausts or forces without doors. Made in ten different sizes.

Belt driven fans 3 to 12 feet in diameter, for steam, gasoline or electric power. Complete bulletins of application.



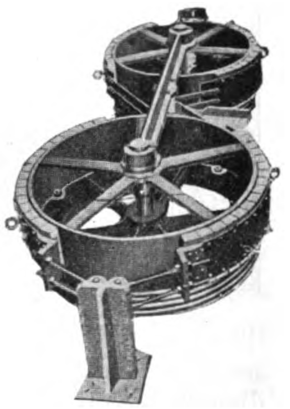
Direct Connected Type.



Made in the following sizes for direct or alternate current:

Diam. of Fan	R. M. P. of Fan	Periphery Speed	H. P. of Motor	Cu. ft. air per min., thousand
3 ft.	725	6,830	6	15 to 20
4 ft.	600	7,536	10	20 to 35
5 ft.	450	6,955	10-12½	35 to 50
5 ft.	600	9,420	15	40 to 60
6 ft.	350	6,597	15	40 to 60
6 ft.	500	9,425	20	50 to 70
7 ft.	300	7,260	20	50 to 80
7 ft.	450	9,900	30	60 to 90
8 ft.	300	7,530	25	60 to 85
8 ft.	400	10,004	40	70 to 120

Incline Plane Machinery



Seventeen sizes to select from. The most complete line in the United States. A machine for every grade and duty. Made under our patents. In use everywhere. Get Bulletin 20 for further information. The most complete book printed on incline planes.

Electric Driven Pumps

Have a reputation for durability, efficiency and economy of operation. They are thoroughly dependable under all conditions.

General Specifications

Elevations—All pumps are designed to work against a maximum of 300 ft. including friction.

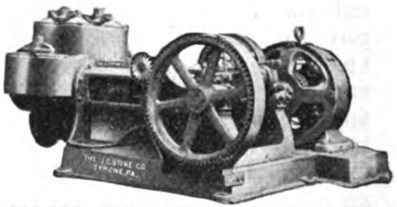
Cylinder—Dense grey iron, fitted with renewable anti-acid bronze liner. Solid anti-acid bronze cylinder furnished when specified.

Valves—Are first quality rubber with bronze backing plates. Valve seats, stems and springs are anti-acid bronze. Piston rod—genuine drawn bronze—not cast.

Crank Shaft—Open hearth, high carbon steel, carefully machined.

Gears—Machine cut from solid blanks; steel pinions, guarded for safety.

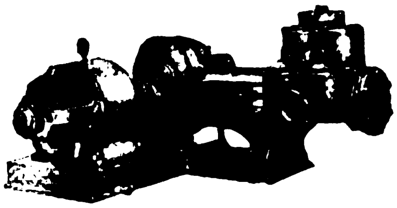
Motors—Of you own selection of the proper size to work continuously.



200-250 Gallon Duplex. 5" suction; 4" discharge. Can be fitted up with any Type of Motor.

Connecting Rod—Of marine type of good length. Strong and durable.

Accessibility — Everything get-atable. Only two nuts to unscrew to get at all valves. Everything standard. All made to gauges.



Made in four sizes, 30 to 250 gallons.

Made in the following sizes:

30-40 gallon—Cylinder 4" bore; 5" stroke; 2½" suction; 2" discharge. Motor 2 to 3 horse power. Direct or alternating current.

60-80 gallon—Cylinder 5" bore; 6" stroke; 3" suction; 2½" discharge. Motor 3, 5 or 7½ horse power. Direct or alternating current.

100-125 gallon—Cylinder 6" bore; 8" stroke; 4" suction; 3" discharge. Motor 5, 7½ or 10 horse power. Direct or alternating current.

200-250 gallon—(Duplex) Cylinder 6" bore; 8" stroke; 5" suction; 4" discharge. Motor 7½, 10 or 15 horse power. Direct or alternating current.

VULCAN IRON WORKS

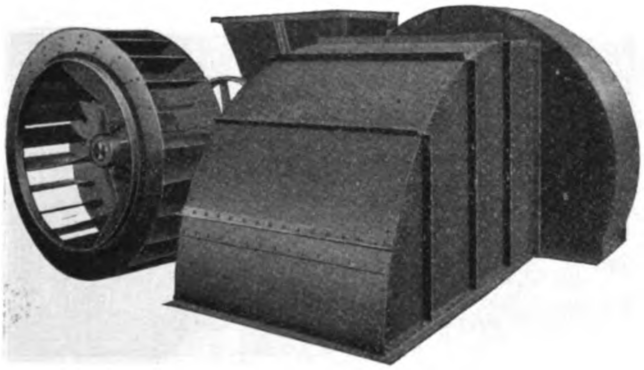
WILKES-BARRE, PA.

NEW YORK CHICAGO

Vulcan Mine Ventilating Fans, Steam and Electric Hoists; Steam, Gasoline and Air Locomotives

Fan furnished to one of the large anthracite companies.

Another fan provided with steel airways.



One of the smaller types made by us showing another form of steel airway.

Engineering Service to Prospective Purchasers

Vulcan ventilating engineers are always ready to co-operate with prospective purchasers in deciding upon just the right apparatus for their specific conditions, all this without obligation.

For complete list of Vulcan Products see page 387.

Four basic principles enter into the design and construction of Vulcan Mine Ventilating Equipment:—

1. High efficiency.
2. Low power consumption.
3. Absolute and continuous reliability.
4. Lowest possible maintenance cost.

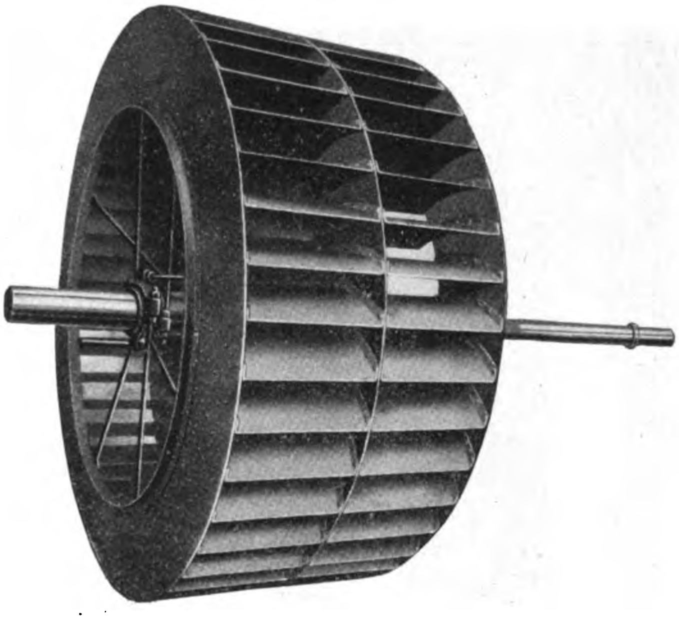
These objects have been attained in service by Vulcan Equipment.

The best assurance of steady production from mines is an even and continuous supply of fresh air. In addition to the greater amount of work secured by an adequate supply of clean air, safety from gases is assured.

The needs of the mine are subject to a variation which can be met only if the ventilating equipment has been designed to meet the full range of these fluctuations. This means more than just the right curve to the vanes, more than smooth bearings offering a minimum of friction, more than strong structural design, adequate air locks and current reversing provisions. It means all of these things and many more so that a fan shall fulfill the task required of it in each individual case; so that it may be run at varying capacities and yet not waste power; and so that it may be dependable in emergencies.

The spokes in Vulcan fans are all in tension so that buckling from air pressure on the vanes is virtually impossible. Further, this spoke arrangement makes for lighter construction without loss of strength, as well as for better mechanical balance.

Vane curvature has been worked out very carefully. Cross eddies and other phenomena that frequently impair fan efficiency have been eliminated.



BEMIS BRO. BAG CO.

1500 FOURTH ST. ST. LOUIS, U. S. A

Ventilating Entries

FLEXOID tubing is a new system of ventilation in driving single entries—eliminating lost time after blasting.

The system consists of forcing air through a tough, flexible air duct. It is made of a strong canvas treated with a preserving compound that effectively protects the fibres against the action of dry rot, weather exposure and acid water. The canvas is thoroughly saturated with the compound, then coated with a heavy preservative that makes the finished product airtight and waterproof.

It is suspended from a pipe or wire or may be laid along the floor of the entry. It is carried near the face and unless the shots are very heavy, it is not affected. For heavy blasting it is rolled back a few feet, which provides ample protection against flying pieces.

The fans used with FLEXOID are small booster fans made by any of the standard fan companies. Any fan producing a static pressure up to 3″ water gauge, depending on the volume and distance the air is required, will be satisfactory.

The principal use of the system in coal mines is the driving of single entries any distance practical with one blower.

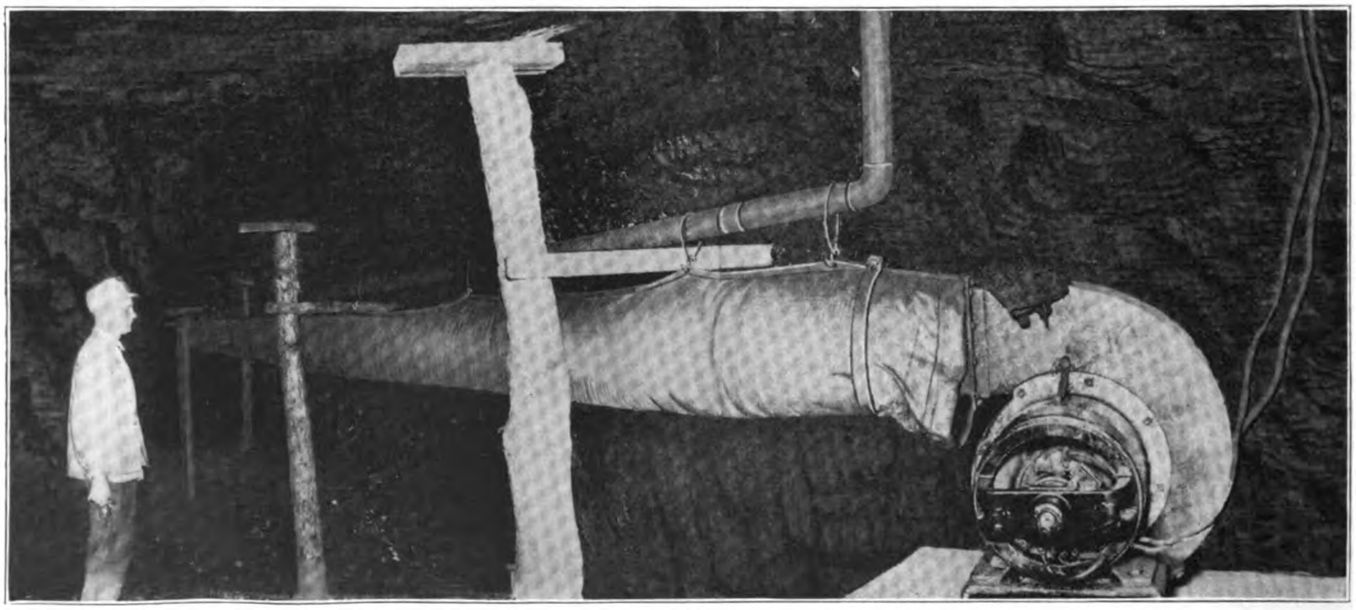
Before FLEXOID tubing was placed on the market, it was impossible to do this. Practically the only available method was to use a line brattice which is successful for short distances only. For this work FLEXOID is so far superior to line brottices, there is no comparison.

In emergency work, driving air courses, cut offs, sinking shafts, clearing gases, gas pockets, FLEXOID is a great saver. It eliminates the necessity of parallel entries with double yardage. It also eliminates cross cuts, both their initial and up-keep cost. It provides a strong barrier pillar and presents an unbroken entry should an explosion occur.

The best way to determine the value of this new idea is to try the system fully at our risk.

It has proven such a great success whenever installed that we will ship to any responsible mine for sixty days trial several hundred feet of the tubing. The operator is at liberty to put this to every test. If at the end of that time FLEXOID has not fulfilled all claims made for it—if it is not producing results, the tubing can be returned to us charges collect.

Take advantage of this offer—write for full particulars.



ILG ELECTRIC VENTILATING CO.

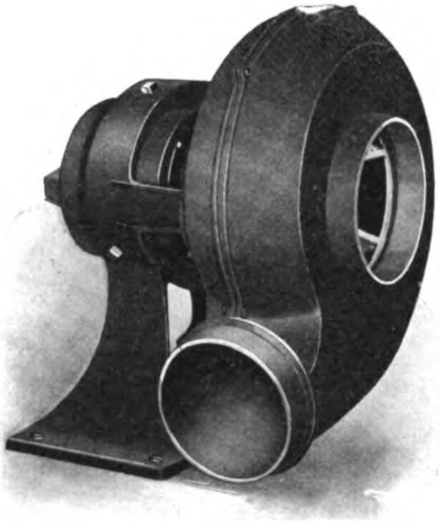
133 Whiting St. CHICAGO, ILLINOIS

District Sales Offices:

NEW YORK PHILADELPHIA CLEVELAND PITTSBURGH

Products

Mine ventilating fans, self-cooled motor propeller fans, disc fans, Centrifugal blowers and exhausters, direct connected and belted, volume blowers, pressure blowers, booster blowers and fans, automatic shutters or louvers, guards for fans, penthouses for fans, air washing and air conditioning apparatus, portable blowers for mines.



Portable Blower, Direct Connected.

Portable Blower, Direct Connected

Can be used in connection with non-collapsible hose to blow air distances up to 500 feet. Blowers are furnished direct connected for any current and are readily portable.

Multiblade Blower, Direct Connected.

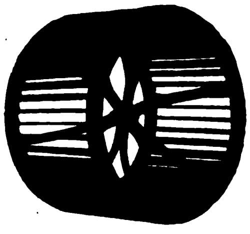
Self Cooled Motor Propellor Fan.

Self Cooled Motor Propeller Fans

Are ideal for handling large volumes against low resistance. Furnished direct connected for air deliveries from 1,000 c. f. m. to 50,000 c. f. m. Quick shipments.

Write for 1917 Propeller Fan Catalog.

Multiblade Blower Belted.



Multiblade Wheel.

Multiblade Blower, Direct Connected

Ilg Universal Blowers with multiblade wheels are very easy to install as it is necessary only to fasten down four feet on either direct connected or belted type. Any blower can be changed on the job to any discharge or drive. Furnished direct connected for any current or voltage. Write for 100-page loose leaf catalog, giving pictures, prices, and performance table, and a complete encyclopedia of air moving data.

THE CUTLER-HAMMER MFG. CO.

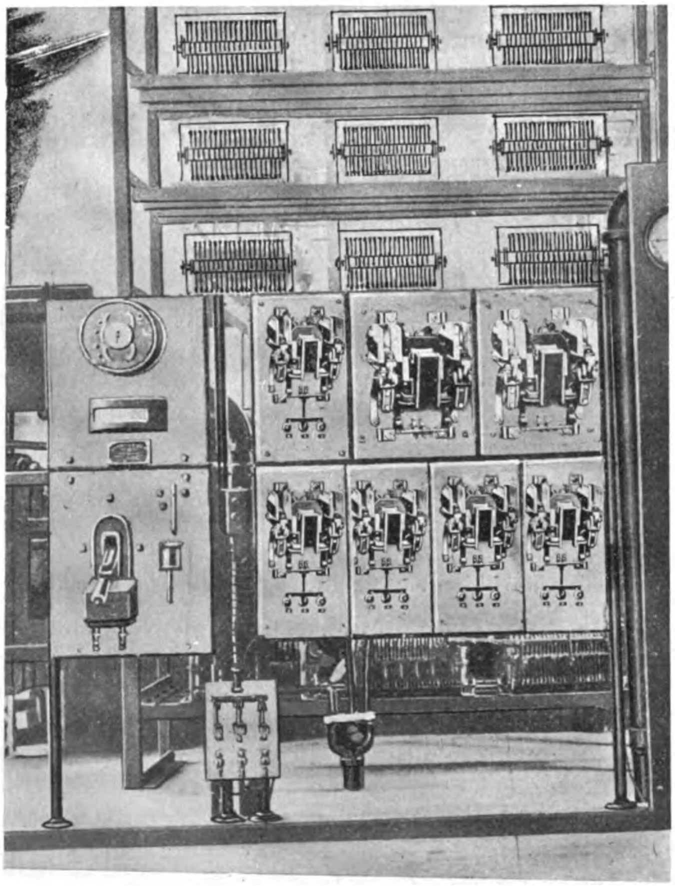
MILWAUKEE, WISCONSIN

DISTRICT SALES OFFICES

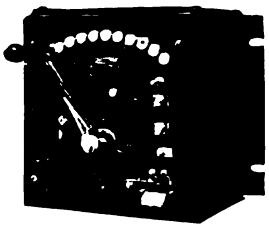
Pittsburgh...........Farmers' Bank Bldg.
Philadelphia.........Commonwealth Bldg.
New York..Hudson Terminal, 50 Church St.
Chicago................People's Gas Bldg.
Boston....................77 Franklin St.
Cleveland..................Guardian Bldg.
Cincinnati..................Gwynne Bldg.
San Francisco, Los Angeles, Seattle.

C-H Electric Motor Regulating and Control Apparatus for use with Mine Fans, Pumps, Compressors, and other Motor-driven Machinery

The Cutler-Hammer Manufacturing Company has specialized in the design and construction of electric control apparatus for motors for the last 23 years. The complete line for **mine service** includes both Manual and Automatic Controllers for hoists, fans, pumps, rope hauls, cableways, storage battery locomotives and tipples, as well as Battery Charging Equipments for miners' storage battery lamps and for electric locomotives and trucks. C-H Magnetic Separating Pulleys have been used for years for removing iron from the coal on conveyors and picking tables.



Automatic Controller for Mine Exhaust and Blowing Fan driven by a 750 H. P. 2200-volt, three-phase wound-rotor motor.



Fan Duty Motor Speed Regulator.

Moisture-Proof Motor Starter.

In the design of controllers for mine service special attention has been paid to the following conditions:

1. **Moisture conditions** and **acid reaction** of **mine waters** have been met by impregnating all coils;—by special resistance;—by using copper and brass as far as possible;—and by japanning and spraying all iron parts.

2. **Fluctuating Voltage conditions** have been met by using coils that operate over a wide range of voltage and by employing all heavy duty resistance for starting service.

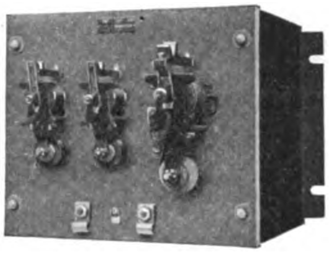
3. **Reliability,**—durable, tried construction used throughout with wearing parts renewable.

4. **Motor Protection** is provided against failure of voltage, interruption of the current supply and overload.

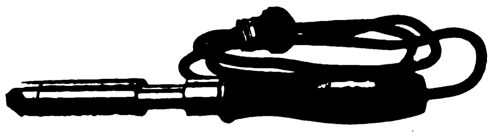
5. **Continuous Service.** In case of drop in the voltage of the system, the special Cutler-Hammer "Mine Duty" resistance and solenoid coils permit the motor to **keep on running** at reduced speeds **without** causing **sparking** at the brushes.

Special controllers are made for use in mines having a large number of self-starting direct current motors so as to make it unnecessary to block the circuit breakers in the power house or have the attendant hold the circuit breaker closed while the motors are starting due to the circuit breaker opening on a short circuit.

D. C. Automatic Motor Starter, time limit acceleration type, Bulletin 6105.

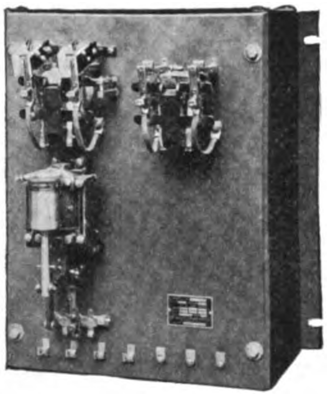

Bulletin 6205. Magnetic Lockout Switch Automatic Starter.

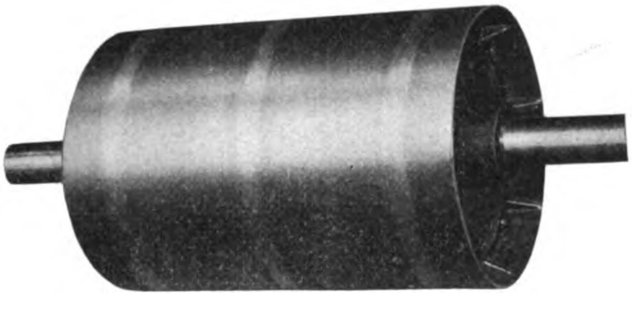
Controllers are made for mines having a small number of motors and buying street car current so that under no condition, from no load to full load, can more than 500 volts enter the mine.

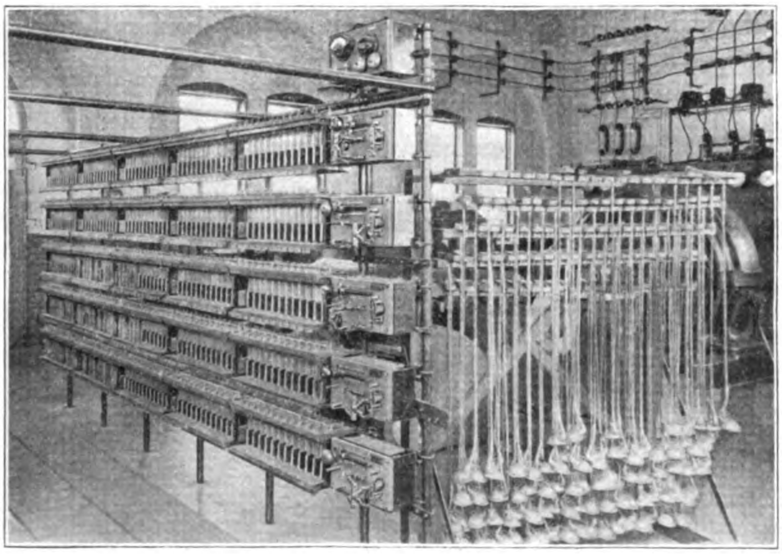

C-H Electric Soldering Iron.

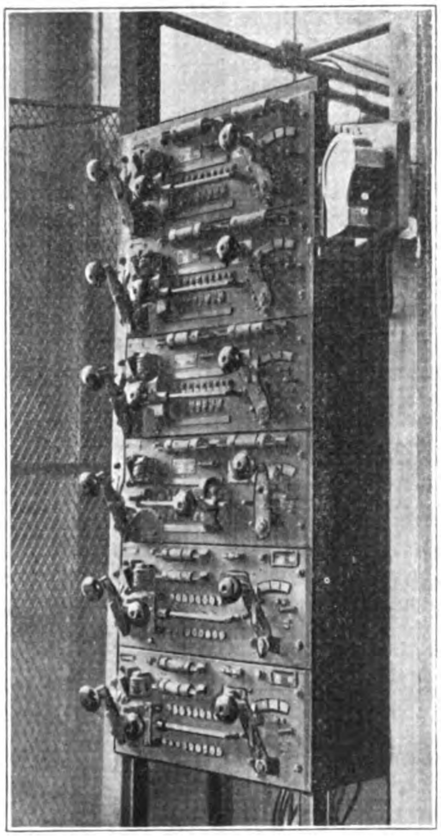
Controllers are made for operation in the opening of new mines, making provision for having the motor operated ventilating equipment used as the entries are extended.

Automatic Starters are made for small motors in gaseous mines to automatically start and stop the motor-driven pump according to predetermined water levels in the sump.


Automatic Controller, operating in conjunction with two-speed squirrel cage motor, direct connected to booster fan.


Magnetic Separating Pulley, used with conveyors to remove pick heads, bolts, nuts, etc., from coal. Ask for Booklet S.


C-H Charging Equipment for Miner's Electric Lamps.


Six C-H Universal Units—Used for charging battery locomotives and industrial trucks.

BACHARACH INDUSTRIAL INSTRUMENT CO.

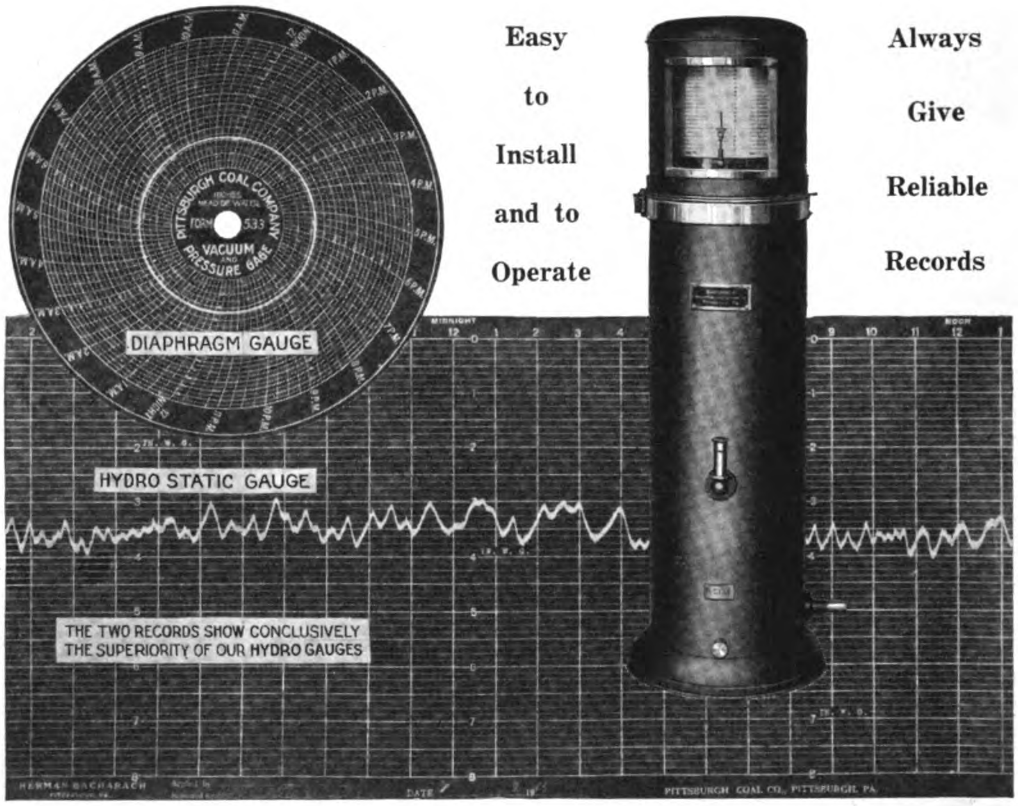
Manufacturers of Precision Instruments,
PITTSBURGH, PA.

"HYDRO"

Pressure Recorders and Velocity Meters

Control Ventilation in Mines

Air Delivery Directly Recorded in Cubic Feet



Easy to Install and to Operate

Always Give Reliable Records

THE ESSENTIAL FEATURES EMBODIED IN "HYDROS" ARE

Simple Design

The action of the Hydro instruments depends upon two elements only, i. e., a well balanced float and a liquid (water) both within a tank.

Practical Construction

Because there are no levers, racks, pinions, stuffing boxes, etc. (such as are used in connection with diaphragm, spring gauges, etc.) which continually cause trouble and inaccurate indications. The use of a liquid and a penrod rigidly connected to the float eliminates intricate mechanism.

Long Life

Is assured on account of the absence of friction and wearing surfaces.

Low Cost of Maintenance

The cost of maintenance is practically nil because there are no parts to wear, the main expense being a chart a day.

Least Attention

Is required because the instrument does not necessitate accurate leveling or any care that involves the personal equation of those using it.

Wide Range of Application

HYDRO instruments are built for any pressures to be considered in and about mines. Exceedingly high magnifications can be employed where very low pressures or velocities should be determined.

Accurate Records

Are obtained on account of the sensitiveness of the apparatus.

Succinct Charts

Because the ordinates are rectangular, thereby eliminating distortion.

GENERAL ELECTRIC COMPANY

General Office
Schenectady, N Y

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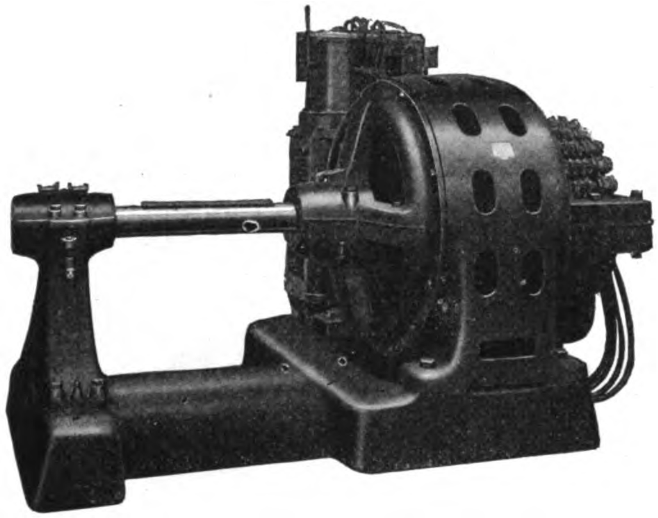
Electrical

Sales Offices
In All Large Cities

Electrical Equipment for Mines---Motors

The fan, a vital factor in the operation of many mines, has also received its full share of attention in the progressive application of electric power in the mining industry.



250 H. P., 2200 Volt Brush Shifting Motor for Driving Mine Fans.

The well known advantages of alternating current from the standpoint of generation and distribution have been somewhat handicaped in application in the numerous instances where, for one reason or another, adjustable speed drives were required. For constant speed drives the squirrel cage induction motor offers practically ideal characteristics.

The induction motor with phase wound secondary and rheostatic control has been widely supplied and with entire success save for the handicap inherent with this form of control, i. e., a reduction in efficiency directly proportional to the reduction in speed.

The importance of gaining even a few per cent in efficiency on a 24-hour every-day-in-the-year load will warrant considerable careful attention to the fan drive motors supplied by the General Electric Company.

The adaptation to American conditions of the polyphase brush shifting commutator motor marks an important advance in the application of motor drive to fan service. This type of motor is peculiar in that no external control equipment is required, the entire range of speed from standstill to maximum being obtained by shifting the brushes forward from the neutral position. The practical operating range of speeds varies with the application, but for fan service may be assumed to extend from its normal rated value down to approximately one third speed.

At rated load and speed, the power factor is practically unity and throughout the operating range the apparent efficiency is usually considerably better than for the induction motor with rheostatic control. With brushes at neutral and motor at standstill, a magnetizing current of approximately 10% of normal full load current is drawn from the line.

A second method applicable to standard induction motors with phase wound secondaries involves a polyphase commutator motor which transforms the slip energy of the main motor, taken at voltage and frequency depending upon the fan speed, and drives a standard squirrel cage motor electrically connected to the main supply system, slightly above synchronism, thus causing it to operate as an induction generator. It thus returns to the system energy proportional to the drop in speed of the main motor less, of course, the losses in the regulating set. This method also affords means of correcting the power factor to any desired value and shows a very high efficiency over the entire operating range. This range varies roughly from 35% regulation on 60 cycle systems to 55% on 25 cycle systems.

LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

High Grade Chain Drives For All Purposes

New York...............299 Broadway
Pittsburgh..........1501 Park Building
Boston..................49 Federal St.
St. Louis...Central National Bank Bldg.
Buffalo............698 Ellicott Square
Wilkes-Barre..2nd National Bank Bldg.
Detroit...........732 Dime Bank Bldg.
Cleveland........429 Rockefeller Bldg.
Seattle.........576 First Avenue South
Portland, Ore.........1st and Stark Sts.
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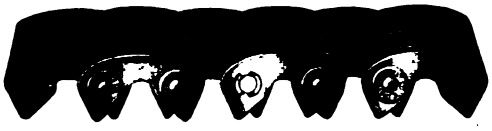
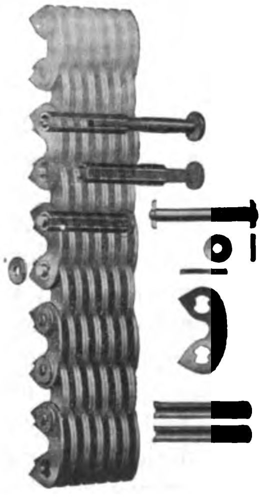
Knoxville, D. T. Blakey...Empire Bldg.
New Orleans, C. O. Hinz.............
................Hibernia Bank Bldg.
San Francisco..........461 Market St.
Birmingham......McCrossin & Darrah
Louisville, Frederick Wehle, Starks Bldg.
Charlotte, N. C., J. S. Cothran........
............Commercial Bank Bldg.
Toronto, Can., Canada Link-Belt Co., Ltd.

Link-Belt Silent Chain is the ideal method of transmitting power—from prime move to machine, or from line to countershaft, for Pumps, Mine Fans, Lineshafts, etc., and any place around the mine where it is important to transmit power without slip or loss. It is as flexible as a belt, positive as a gear, and more efficient than either, (98.2% efficient on actual test). The success of the drive is due entirely to the superiority of its joint construction, which is patented, and found in no other chain. See illustrations. The segmental liners or bushings, which are removable, extend across the entire width of the chain, thus doubling the bearing surface and having the bearing pressure on the joint. The bushings are case-hardened and bear upon the case-hardened pin. The latter is free to, and does rotate with reference to the bushings and presents every particle of its surface for wear. As a result it wears uniformly, keeps round, and the chain maintains to the end its high initial efficiency. Transmits any power at any reasonable speed. A safety first means of transmitting power which combines the advantages of the leather belt and spur gear, and eliminates their disadvantages. Thousands in daily use under all conditions.

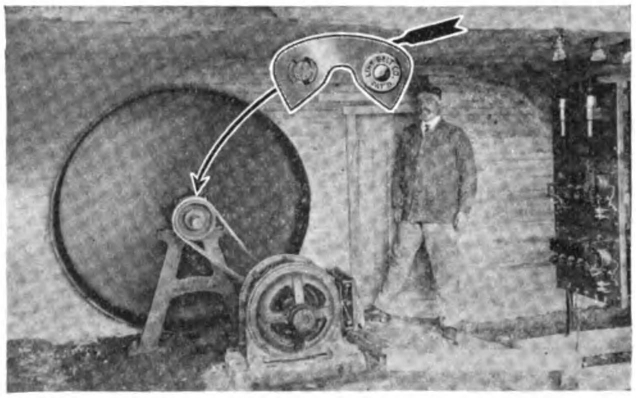


Look for the Name on the Washers.
Look for the Liners in the Joints.



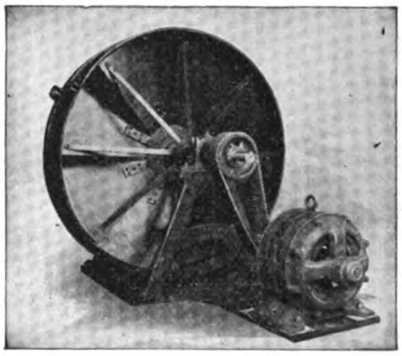
The best is none too good where human life depends on continuous operation.

For driving Fans, Link-Belt Silent Chain permits of compact construction, and requires but a minimum of attention. It is positive, absolutely reliable, and can therefore be depended upon for this all-important work of supplying miners with fresh air. It is the "Safety First" means of transmitting power.



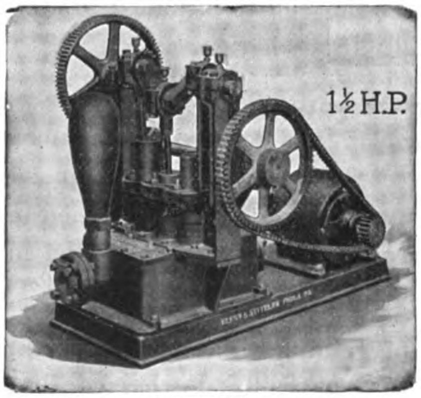
Link-Belt Silent Chain Operating Mine Fan.

We have installed many drives for this service which have been in operation for eight years and longer. The only attention they have ever required is periodic oiling.



Mine Fan Drive.

Link-Belt Silent Chain is a reliable, compact, and highly efficient drive for any machinery around the mine. You can learn all about it by writing for 128 page Data Book No. 125. It contains information for every man who is interested in the economical transmission of power. Sent postpaid on request. Address nearest office. Or send for a Link-Belt service man to explain the advantages personally.



Pump Drive.

MORSE CHAIN COMPANY

ITHACA, NEW YORK

Offices and Representatives:

BOSTON, 141 Milk Street.
CHICAGO, Merchants L. & T. Bldg.
CLEVELAND, Engineers Bldg.
DETROIT, 1003 Woodward Avenue.
NEW YORK, 50 Church Street.
PITTSBURGH, Westinghouse Bldg.

SAN FRANCISCO, Monadnock Bldg.
ATLANTA, Earl F. Scott, M. E., Candler Bldg.
GREENSBORO, N. C., G. W. Pritchett, 805 Ashboro Street.
KANSAS CITY, Morse Engineering Co., R. A. Long Bldg.
MINNEAPOLIS, Strong-Scott Mfg. Co., 413 Third Street, S.
ST. LOUIS, Morse Engineering Co., Chemical Bldg.

MORSE SILENT CHAINS ON ALL MINING MACHINERY

MORSE CHAIN COMPANY ITHACA, NEW YORK

LARGEST MANUFACTURERS OF SILENT CHAINS IN THE WORLD

Product

MORSE FRICTIONLESS "ROCKER-JOINT" SILENT CHAINS AND SPROCKETS—A HIGH SPEED, POSITIVE, FLEXIBLE DRIVE FOR COAL MINING MACHINERY. THE IDEAL METHOD OF TRANSMITTING POWER TO PUMPS, FANS, BLOWERS, CONVEYORS, COMPRESSORS, CRUSHERS AND LINESHAFTS. ELIMINATES SLIP AND LOSS. FROM ¼ H. P. TO 5,000 H. P. FOR HIGH OR LOW SPEED.

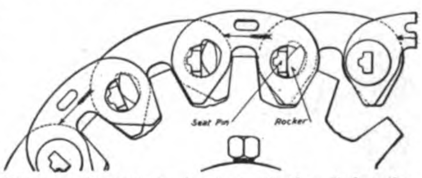
A Typical Morse Chain and Sprocket.

Type

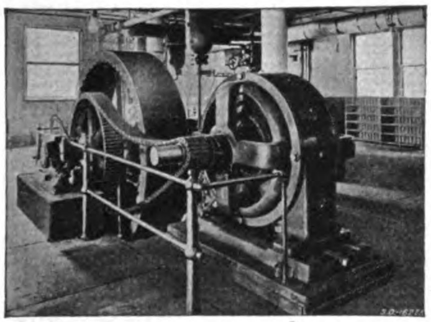
All the so-called "silent chains" are, in general appearance, practically alike. Each type is essentially a steel belt made up of flat steel links so shaped that, when set on edge and assembled in numbers to give a desired width and length of chain, rows of teeth are formed on one side to engage the teeth on the sprockets.

Difference

The difference between the **Morse** Silent Chain and all other types is in that unseen and all-important part, the joint. The **Morse** is constructed with the undeniable fact always in view—**The Joint Must Bear the Burden of Service in Any Chain.**



Sketch Showing Action of the Joint in Morse Chain.


Sixty H. P. Morse Silent Chain Drive to Compressor. Details: 17/111 Teeth, 480/73.5 r.p.m., 87" Centers; Chain 1.5" pitch by 7" wide; Speed 1,020 ft. p. m.

The Exclusive "Rocker Joint" Construction

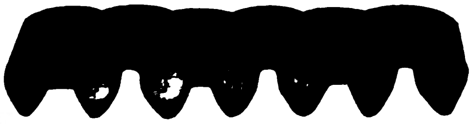
The **Morse** depends upon its construction, not upon lubricant, for its life and efficiency. It has demonstrated its superiority over all others for twenty years by its adaptability for service under all conditions. Two special pins, both seated, form the joint. **No Bushing is Required.** As the chain bends in circling around each sprocket, the **curved side** of one pin rolls or rocks against the broad flat side of the other, eliminating destructive sliding friction entirely. When on the straight run between sprockets, the **flat sides** of both pins are brought together, holding the chain steady and true.

BELT DRIVE 80% GEARING 90% MORSE CHAINS 99%

BELT DRIVE 80% GEARING 90% MORSE CHAINS 99%

Speed

THE MORSE, depending upon its construction instead of upon lubricant for its life and efficiency, can be run at a speed far in excess of other chains, which are limited to the speed at which the oil begins to fly from the joints.


Morse Silent-Running High Speed Chain, Type 25.

Service

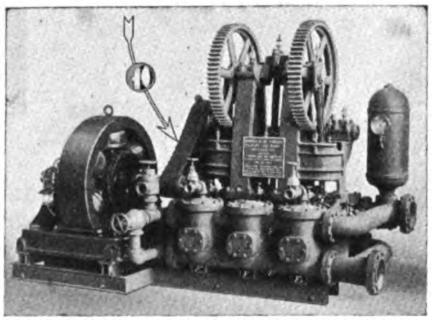
As to durability and long life, it goes without saying that the chain having the least friction at the joints lasts the longest. There is hardly an industry today in which **Morse Silent Chains** are not used as the accepted drive after years of experimentation.

Additional Information

Our Bulletins giving detailed description of the chain and joint construction, also valuable chain and sprocket engineering data, will be sent free upon request to all those interested in better and more efficient power transmission.

Publication Number 14, entitled "Large Power Drives", though not confined to any particular field or industry, includes drives of 100 H. P. each, and upwards to 5,000 H. P., the largest chain drive in the world.

Publication Number 15 includes drives of less than 100 H. P. each. Send for either one or both.


Morse Silent Chain Drive to Rumsey 500 gal. p. m. special fire pump. This illustrates the compact connection possible by employing Morse Silent Chain Drive with electric motor.

Engineering Assistance

Our corps of engineers with years of experience in designing and installing millions of horsepower chain drives will assist you to solve your transmission problems.

This service is rendered gratis. Get in touch with them NOW.

ESTABLISHED 1870

FULTON BAG & COTTON MILLS

MANUFACTURERS OF BRATTICE CLOTH

BROOKLYN, NEW YORK CITY, U. S. A.

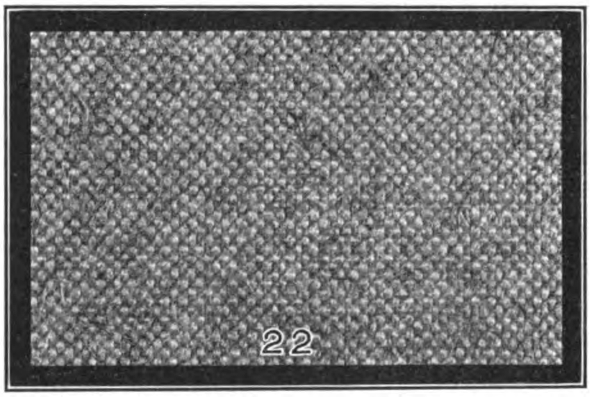
Atlanta New Orleans St. Louis Dallas Oklahoma City

A Brattice Cloth that combines extreme efficiency and extreme economy is the Brattice Cloth for you to use. FFFF Brand possesses both qualities. It is made out of carefully selected fibres, closely woven, and Fireproofed by a chemically scientific process which renders it non-inflammable and at same time practically rot-proof.

FFFF No. 1 is a good Jute Brattice Cloth at a cheap price. A strong, heavy cloth, double warp, durable and non-inflammable. It is especially recommended for temporary brattices and for walls. Preferred to many other qualities sold at much higher prices.

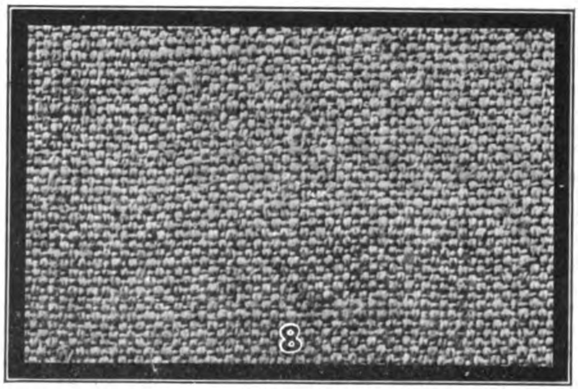
FFFF No. 22. A superior single warp and single weft closely woven fabric, made of selected jute yarns. We recommend this quality next to FFFF No. 8 and have sold it with considerable success in all coal fields for many years.

Always Demand FFFF Brand
Best by Test



Always Demand FFFF Brand
Best by Test

FFFF No. 8 is a non-inflammable Jute Duck constructed out of hard-twisted yarns, for strength, durability and closeness of weave. It makes an ideal Brattice Cloth. Its durability has been established by long years of use, not only in this country, but also in the British Coal Fields and throughout the entire world. The closeness of its weave makes it practically air-tight, thereby wasting the least possible amount of air. It is highly recommended by experts, mine superintendents and students of mine ventilation and efficiency.



Stocks Carried With Leading Jobbers In All Coal Fields
IF YOUR REGULAR JOBBER DOES NOT CARRY FFFF WRITE TO US.
We manufacture other qualities and will gladly send samples and prices.

NO MORE WAITING ON IMPORTATION ORDERS

PROMPT SHIPMENTS FROM OUR NEAREST FACTORY

LAURIN H. TURNER & CO

160 West Jackson Boulevard, Chicago, Ill.

Manufacturers of

BRATTICE CLOTH

LAURIN H. TURNER AND COMPANY

MATCHLESS
NON-
INFLAMMABLE
BRATTICE

160 W. JACKSON BLVD., CHICAGO

Why use any but the best wearing "MATCHLESS" NON-INFLAMMABLE DUCK BRATTICE CLOTH when bratticing your Mines?

Our styles are as follows:

No. 24—is made from the best quality of cotton duck, treated to be non-inflammable. It is made by stitching two or more breadths together with a double stitched seam, same as old sail, for the width required.

No. 20—is a lighter weight, and in 72″ we can furnish it seamless, but in other widths it is made by stitching two or more breadths together with a double stitched seam for the required width.

We claim for our Cotton Duck Brattice longer service than jute, as it will not fray out as quickly. It costs less in the long run. It does not accumulate Coal dust, which is very inflammable, and the best evidence of our claims is the growth of our business and our customers' continued use of our Brattice Cloth.

Prompt shipments as stock always on hand.
Samples and Prices will be furnished on request.

GOODIN REID & CO.

RED
DIAMOND
BRATTICE

CINCINNATI

Converters of

Brattice Cloth

BLACK
DIAMOND
BRATTICE

Red Diamond Everlastic Brattice

Red Diamond Everlastic is flame-proof, water-proof, moisture-proof, dust-proof; all qualities combined in the same fabric.

The non-inflammable quality is guaranteed. It is coated with a special compound which renders the fabric non-porous and air-tight.

There is 300% more wear in our Red Diamond Everlastic Brattice.

Red Diamond Non-Inflammable

Unequaled in its fire-resisting qualities, and is also mildew-proof.

Our treatment increases the strength of the fabric and adds greatly to the wearing quality.

The color, a light red, is most suitable for use in the mine.

It is made of high-grade cotton duck in three styles:

Style "A"

Made from single filling duck. Weight approximately when treated 16 ounces per square yard.

Style "AA"

Made from heavy single filling duck. Weight approximately when treated 16 ounces per square yard.

Style "AAA"

Made from specially constructed heavy double filling duck. Weight when treated approximately 20 ounces.

Black Diamond Water-Proof

This fabric is made specially for use in places where a water-proof fabric with exceptional wearing qualities is required, and where conditions do not require a high degree of non-inflammability.

Our treatment completely coats the yarn and protects it against the influence of moisture.

This material is being used by many of the largest operators after a series of tests demonstrating that it would outlast any other brattice cloth on the market.

Made in four grades:

Number 410 G. R.

Is made of a standard single filling duck. Weight when treated, per square yard, 16 ozs.

Number 308 G. R.

Made of a standard single filling duck. Weight when treated, per square yard, 14 ozs.

Number 1

Made of standard osnaburg. Weight when treated, per square yard, 13 ozs.

Write us for a list of enthusiastically satisfied users of our goods, who buy them in lots from ten rolls up to carloads.

JOHNSTON-MOREHOUSE-DICKEY CO.

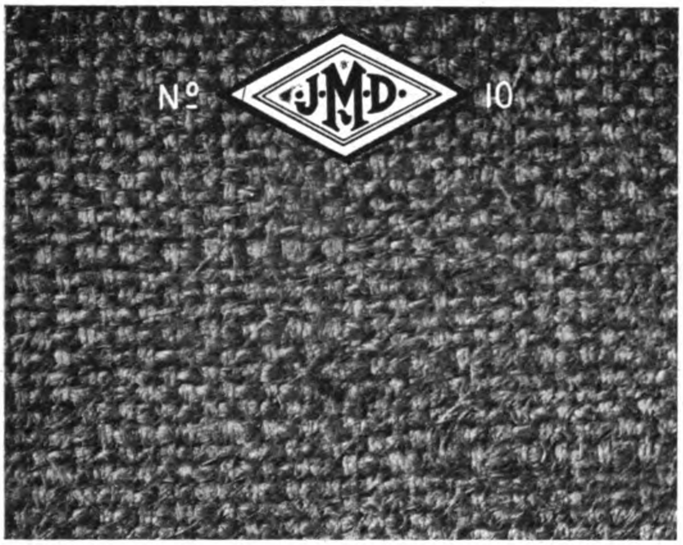
Brattice Cloth Manufacturers

PITTSBURGH, PA.

Established 1902 Court 788

NO. 12

A superior quality, closely woven, non-inflammable Jute Cloth, and is the quality we have made a specialty of for many years and which we recommend as the most satisfactory medium-priced cloth on the market.



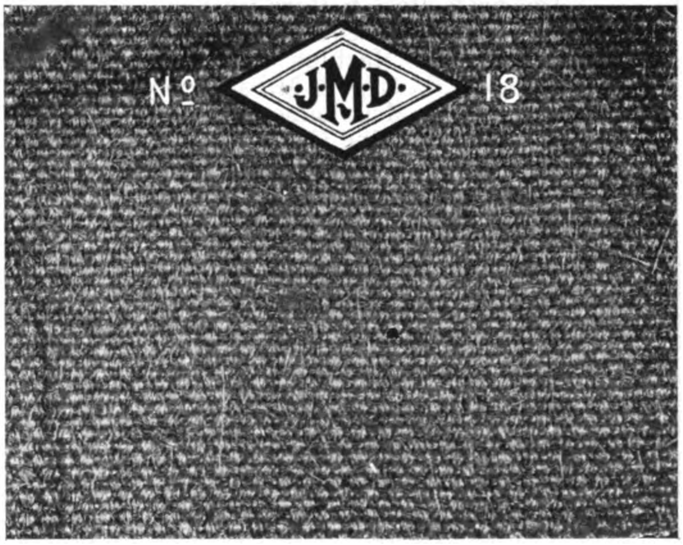
NO. 18

A high-grade, non-inflammable Jute Duck, which we have for many years past supplied to many of the largest colliery companies in the country, and is specially recommended for wet mines.

We make all three grades, in 36″, 48″, 60″, 72″, 84″ and 96″, and are in a position to make prompt shipment.

NO. 10

A good, strong, heavy, non-inflammable Jute Cloth, which has given entire satisfaction wherever used.



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KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

HOISTING AND HAULAGE SECTION

Engineering Data

Specification data for Hoisting Engines.

Chart—Vertical unbalanced loads lifted by First Motion Hoisting Engines at various Steam Pressures with drums from 4 to 12 feet in diameter.

Chart—Showing Power Required to Haul Cars on various pitches.

Chart—Showing Piston speed in feet per minute

Chart—Capacity of face of winding Drums.

Chart—Amount of rope wound on drums of various diameters and faces.

Specification data for Haulage Engines.

Table—Tension on Wire Rope for Inclined Planes.

Chart—Rope speed in feet per minute.

Table—Bending and safe working stresses for Cast Steel Ropes (19 wires) running on sheaves of various diameters.

How to order Wire Rope.

Wire Rope Data (Hoisting).

Wire Rope Data (Haulage).

Inspection, care, lubrication and handling of Wire Rope.

The following manufacturers have catalogue descriptions in this section:

Allis-Chalmers Mfg. Co.
American Steel & Wire Co.
Broderick & Bascom Rope Co.
Cherry Tree Machine Co.
Connellsville Mfg. & Mine Supply Co.
Crawford & McCrimmon Co.
Diamond Machine Co.
Dravo-Doyle Company.
Everhart Brass Co.
Falk Co.
Fisher & Hayes Rope Co.
Flory, S., Mfg. Co.
General Electric Co.
Hazard Mfg. Co.
Holmes, Robt., & Bros.
Interstate Equipment Corp.
Ironsides Co., The.
Leschen, A., & Sons Rope Co.
Lidgerwood Mfg. Co.
Litchfield Fdry. & Machine Co.
Macomber & Whyte Rope Co.
Medart Patent Pulley Co.
Mining Safety Devices Co., The.
Moon, Geo. C. Co., Inc.
Ottumwa Iron Works, Inc.
Pneumelectric Machine Co.
Roebling's, John A., Sons Co.
Royer & Zweibel.
South Side Foundry & Machine Works.
Texas Co., The.
Thermoid Rubber Co.
Vulcan Iron Works.
Waterbury Co.
Webb, S. C. Company.
Wellman-Seaver-Morgan Co.
Westinghouse Electric & Mfg. Co.
Wright Wire Co.

For additional descriptions of Hoisting and Haulage Equipment, not appearing in this section, refer to Index of Products in front of book.

Information Required for Shaft Hoists

Total height of lift (from bottom to dump)..

Weight of cages and whether self-dumping or platform type ....

Weight of empty car ....

Weight of loaded car (coal)..

Weight of loaded car (rock, if hoisted)...

Are men and material to be handled..

Is hoist to be located at side or end of head frame

give center to center distance of head sheaves...

Diameter of hoisting ropes preferred...

Is operator to be located at hoist or in head frame..

If hoist to be driven by A. C. motor specify voltage, phase and cycle. If to be driven by

D. C. motor give voltage...

If hoist to be steam driven give steam pressure at throttle or steam pressure carried on boilers

and distance from boilers to hoist...

Information Required for Slope Hauls

Maximum length of haul..

Grades in percent as near as possible with length of each and specify curves, if any.................

Number of cars per trip and speed desired or output

in specified time in tons...

Weight of empty car..

Weight of loaded car ....

Are cars equipped with roller bearing wheels or plain...

If hoist to be driven by A. C. motor specify voltage, phase and cycle. If to be driven by

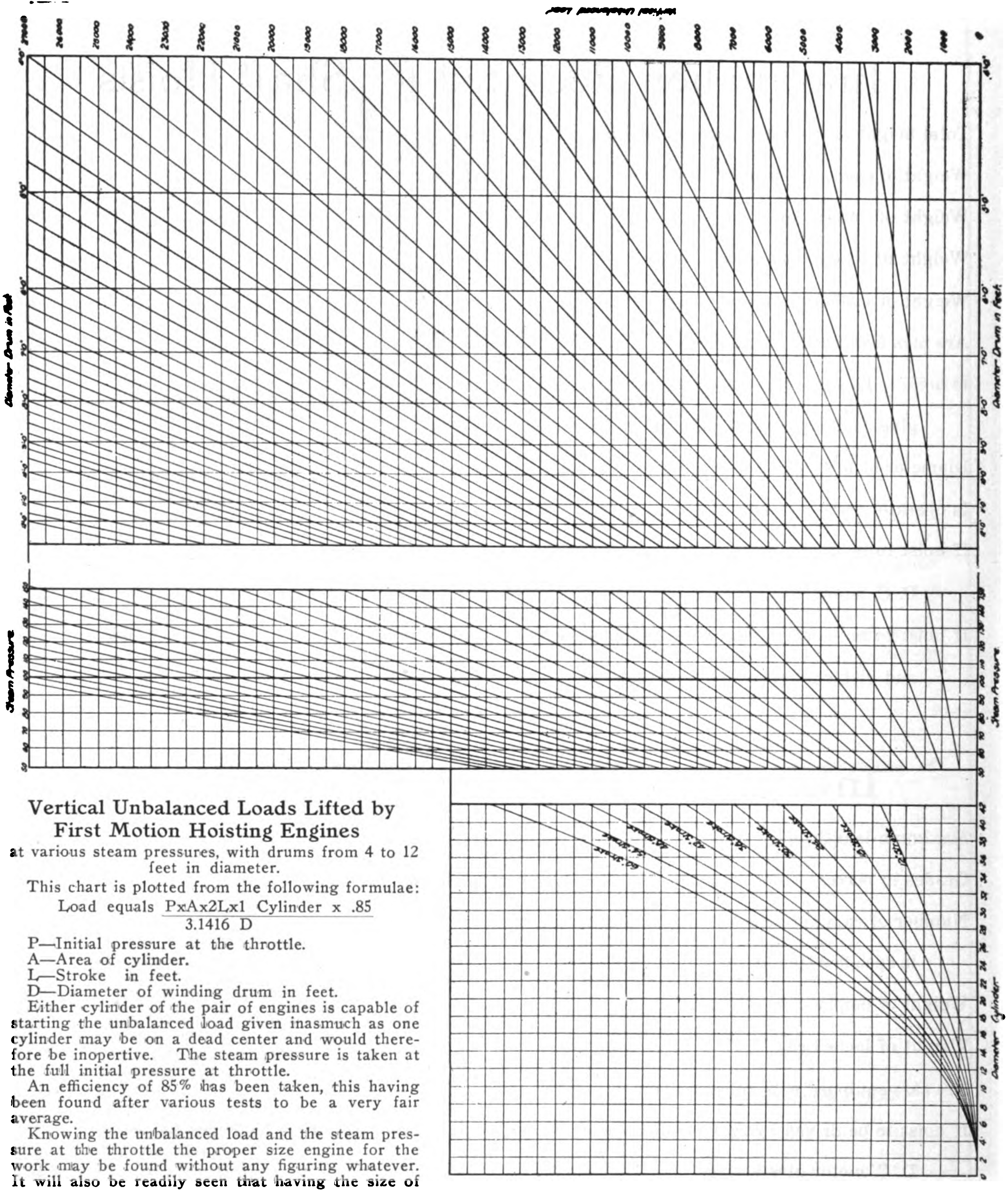
D. C. motor give voltage...

....

....

If hoist to be steam driven give steam pressure at throttle or steam pressure carried on boilers

and distance from boilers to hoist...



Vertical Unbalanced Loads Lifted by First Motion Hoisting Engines

at various steam pressures, with drums from 4 to 12 feet in diameter.

This chart is plotted from the following formulae:

$$\text{Load equals } \frac{P \times A \times 2L \times 1 \text{ Cylinder} \times .85}{3.1416\ D}$$

P—Initial pressure at the throttle.
A—Area of cylinder.
L—Stroke in feet.
D—Diameter of winding drum in feet.

Either cylinder of the pair of engines is capable of starting the unbalanced load given inasmuch as one cylinder may be on a dead center and would therefore be inopertive. The steam pressure is taken at the full initial pressure at throttle.

An efficiency of 85% has been taken, this having been found after various tests to be a very fair average.

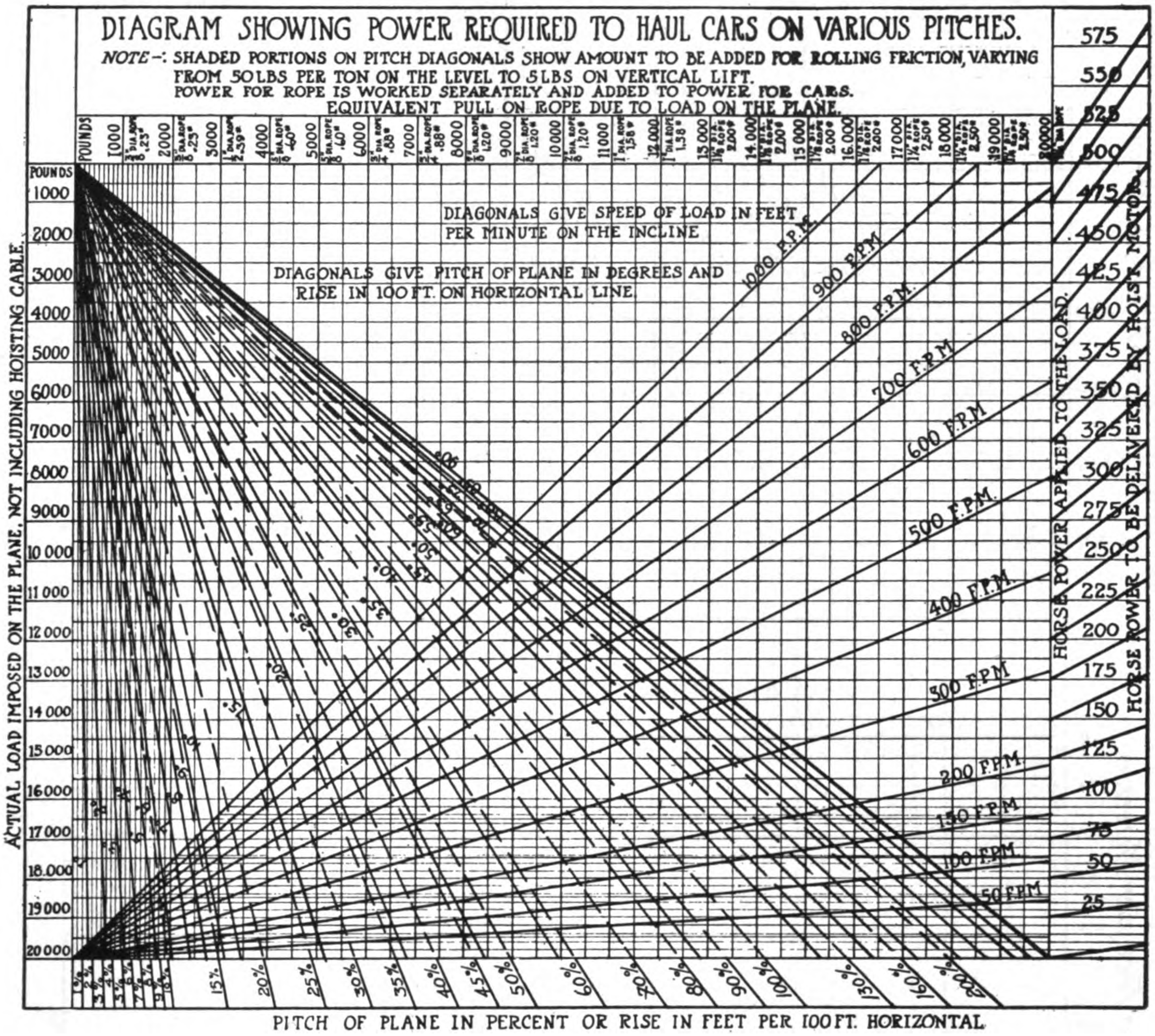
Knowing the unbalanced load and the steam pressure at the throttle the proper size engine for the work may be found without any figuring whatever. It will also be readily seen that having the size of engine cylinders the vertical load that can be lifted by them may also be found for any steam pressure and various diameters of drum.

Example: Find the size engine capable of handling a vertical unbalanced load of 12,000 with 100 pounds steam pressure at the throttle.

The rope manufacturers give the working load for 1" rope as 6.8 tons. However, in actual practice, for this load a 1-¼" rope would probably be used and wound on, say, an 8' 0" diameter drum.

Following the horizontal line marked 12,000 until it is intersected by the diagonal line at or about the vertical line representing an 8' 0" diameter drum; then follow the diagonal line down to left side of chart; follow horizontal line across until it is intersected by diagonal line at or about the line representing 100 pounds steam pressure; follow this diagonal line as previously described to left side of chart; follow horizontal line until proper combination of stroke and diameter are found. For the work in hand the following engines would be satisfactory: viz: 24x48", 26x42" or 28x36"; the 24x48" size would probably be selected.

Courtesy Vulcan Iron Works.



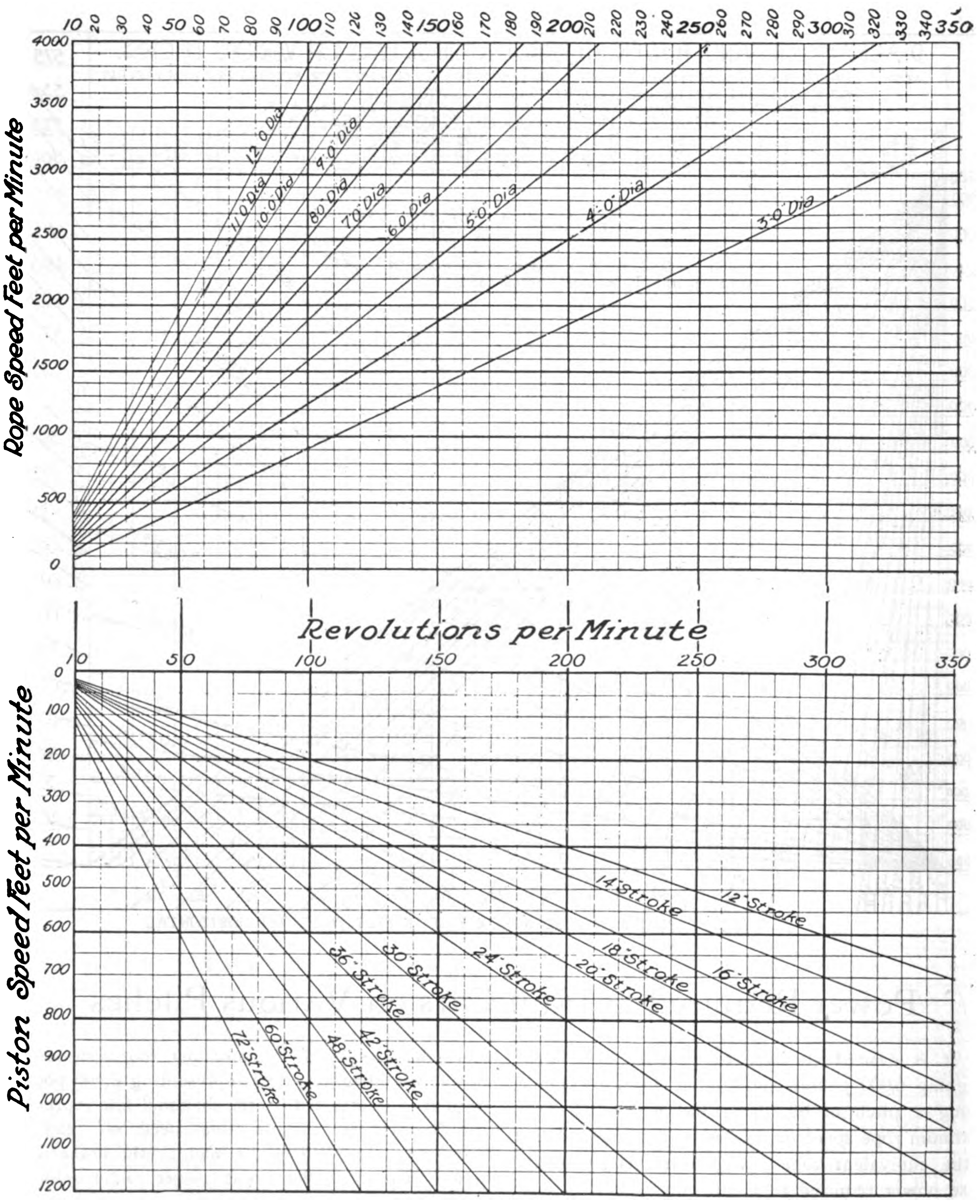
Power Required to Haul Cars on Various Pitches

It is desired to haul two loaded cars, each weighing 6,000 pounds up a plane 1,000 feet long, having a pitch of 40° from the horizontal, at a maximum rope speed of 500 feet per minute. What is the equivalent rope pull? What is the brake horse power required to handle the load?

Example: Two loaded cars weighing 6,000 pounds each equals a load of 12,000 pounds exclusive of winding rope. Follow the horizontal line representing 12,000 on the chart until it is intersected by the diagonal line representing 40°. Directly above this point of intersection will be found the rope pull, which in this case is 7,900 pounds. We also find that a ¾" rope would be satisfactory and that this size rope weighs .88 pounds per foot. Following down this imaginary line representing 7,900 pounds until it is intersected by the diagonal line representing 500 feet per minute rope speed, we read 120 horse power applied to the load, or the brake horse power required. The horse power to be delivered by this hoist motor would be 141; that is, based on an efficiency of 85% for the entire outfit.

We found that ¾" rope would be required and also that this size rope weights .88 pounds per foot; 1,000 feet of rope at .88 pounds equals 880 pounds. By working this out the same way we did for the loaded cars we find it equivalent to nine horse power, which should be added to the 141 horse power, making a total of 150 horse power.

Courtesy Vulcan Iron Works.



Piston Speed, Etc.

In the foregoing proposition assume an average piston speed of 600 feet per minute.

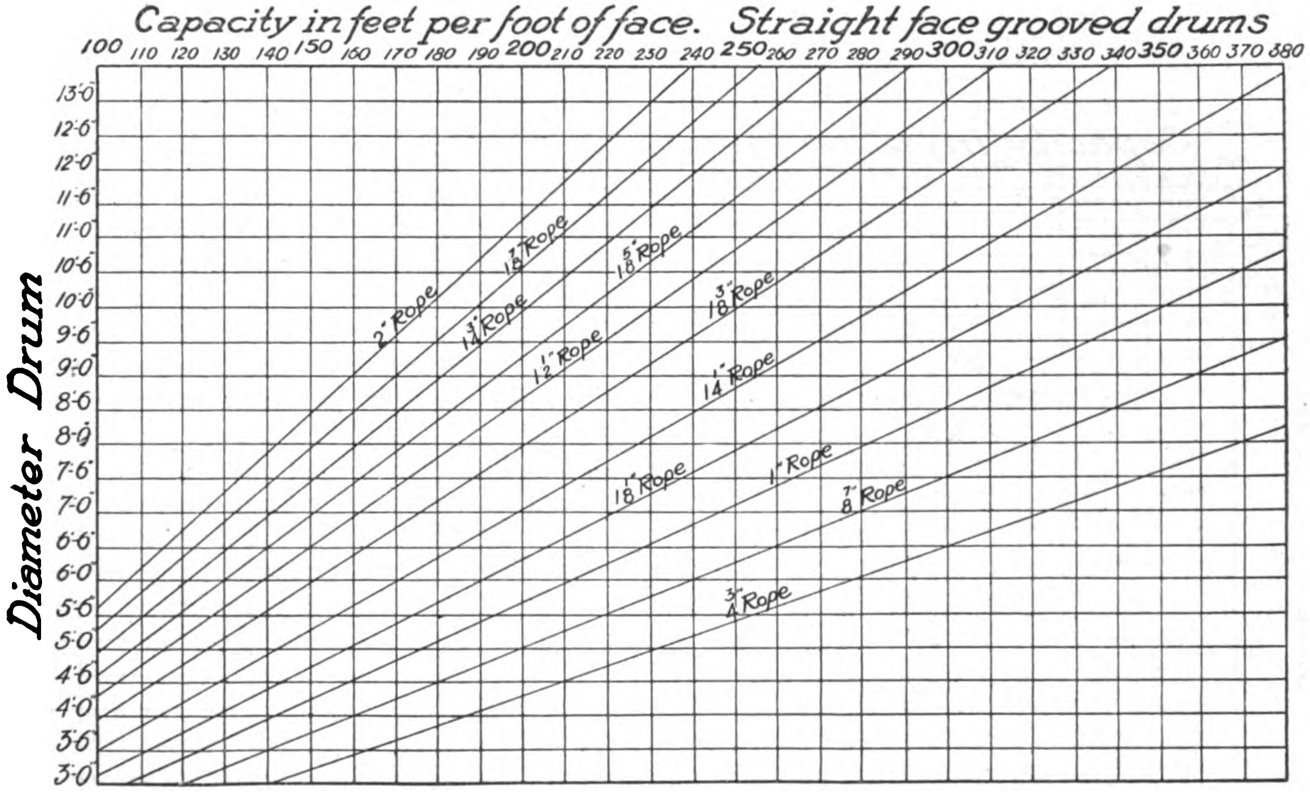
Following the horizontal line at 600 until it is intersected by diagonal line representing 8′ 0″ drum; following this line to the upper section until it is intersected by diagonal line representing 48″ stroke; by following the horizontal line to side of chart the rope speed is found to be 1,890 feet per minute.

Courtesy Vulcan Iron Works.

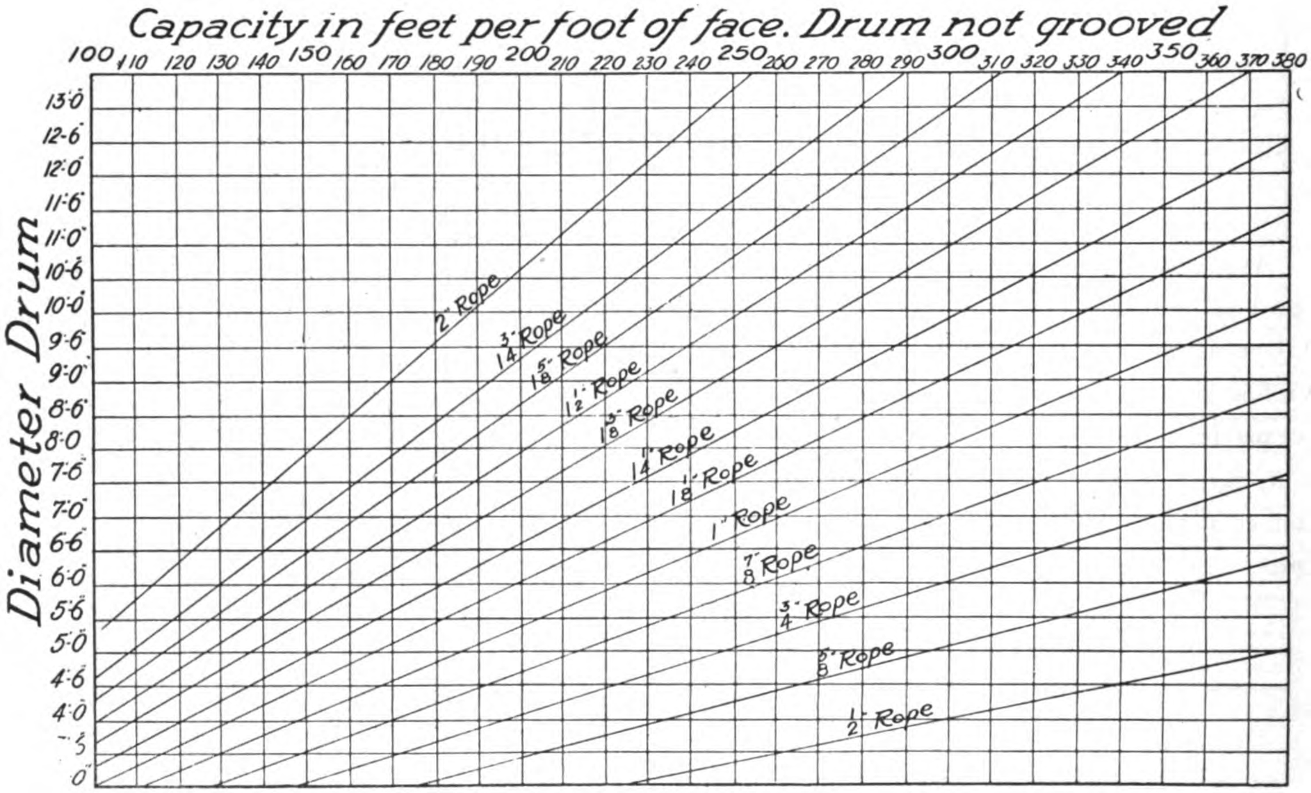
Face of Winding Drum.

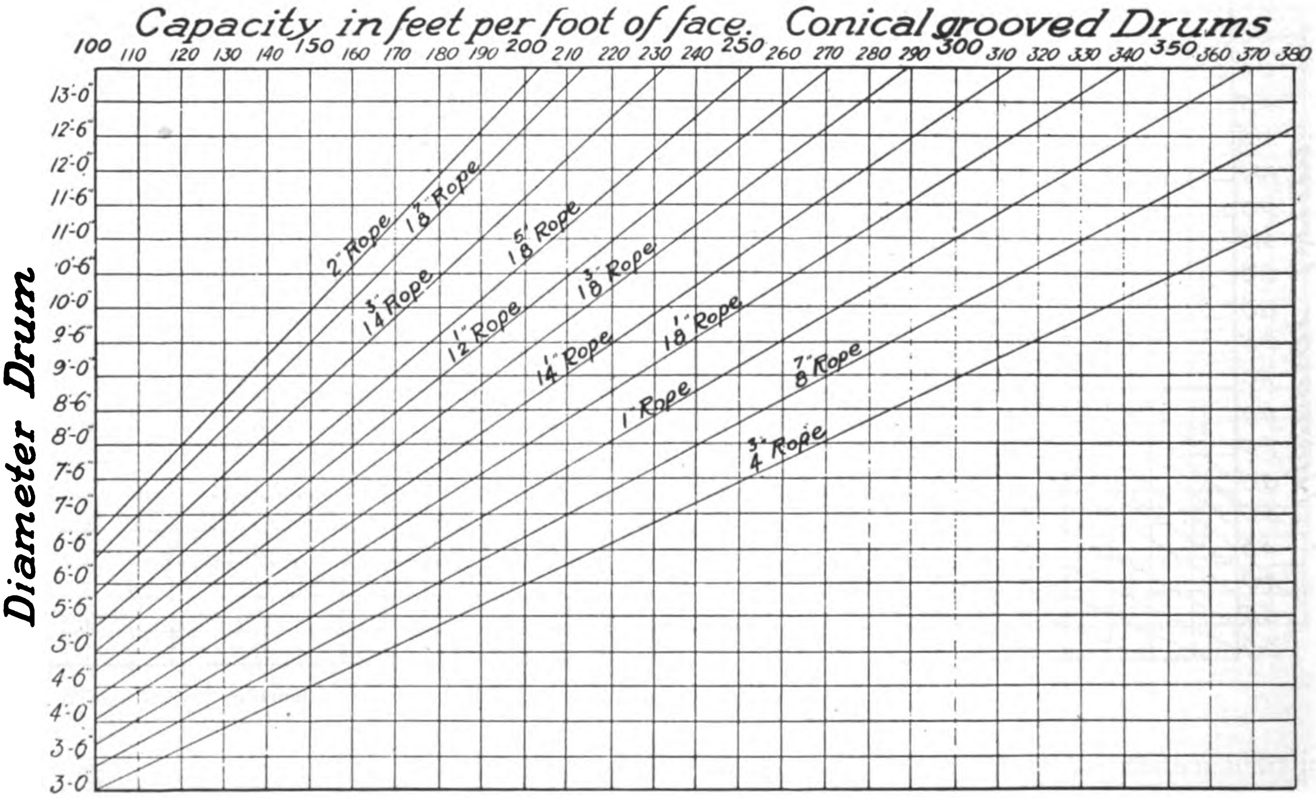
As previously stated, our drum is 8′ 0″ diameter, rope 1-¼″ diameter and shaft 475 feet deep. Refer to the chart marked "Straight Face Grooved Drums." We find that an 8′ 0″ diameter drum will wind 227 feet per foot face. Our drum would therefore have to be, say, 2′ 6″ face, which would allow a sufficient number of grooves at one end of drum for fastening rope.

The charts on straight face drums not grooved, and conical grooved drums would, of course, be used in the same manner as illustrated above. The diameter used for conical drums, however, should be the mean diameter.

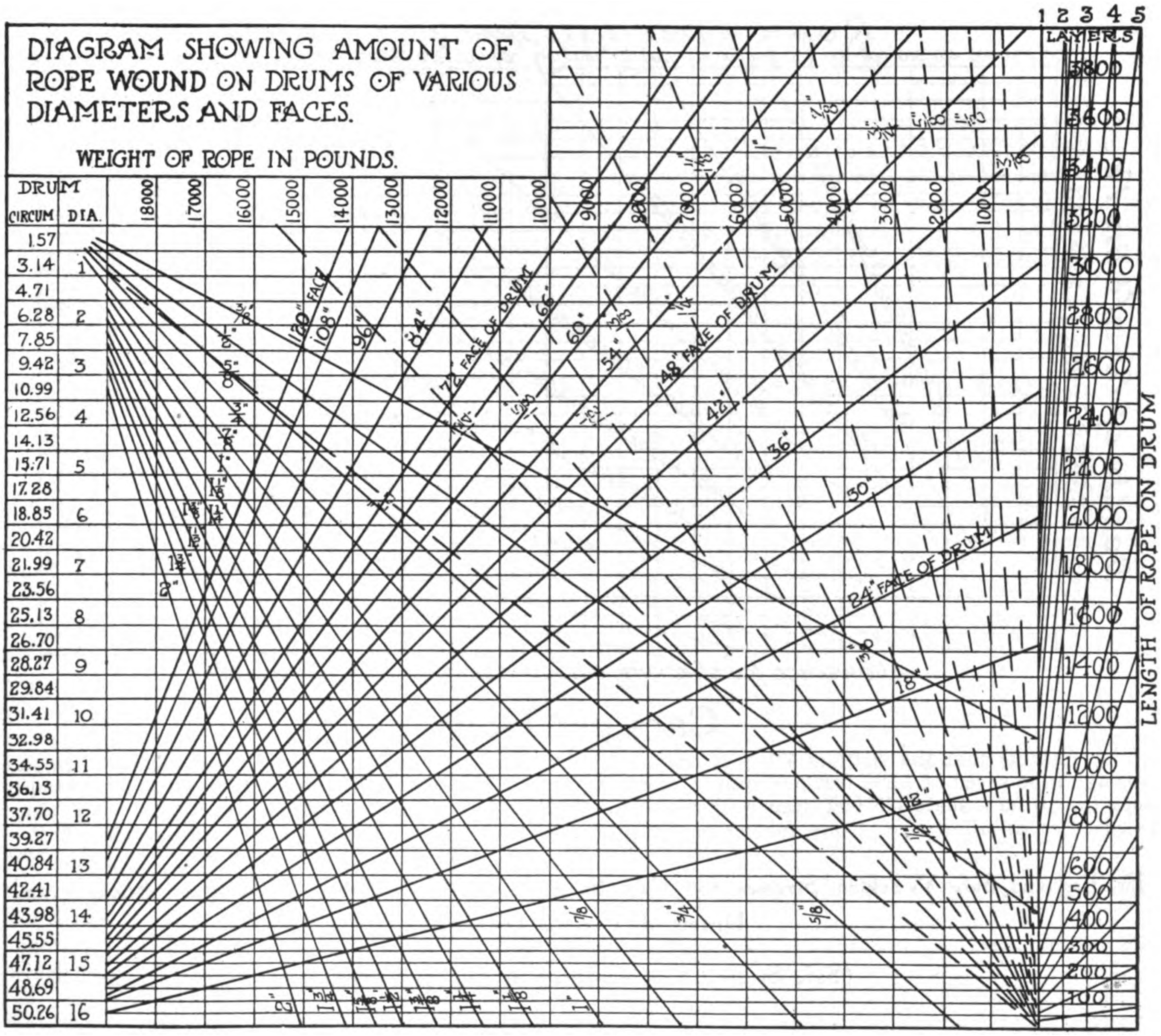


Courtesy Vulcan Iron Works.


Capacity in feet per foot of face. Drum not grooved


Capacity in feet per foot of face. Conical grooved Drums

Courtesy Vulcan Iron Works.



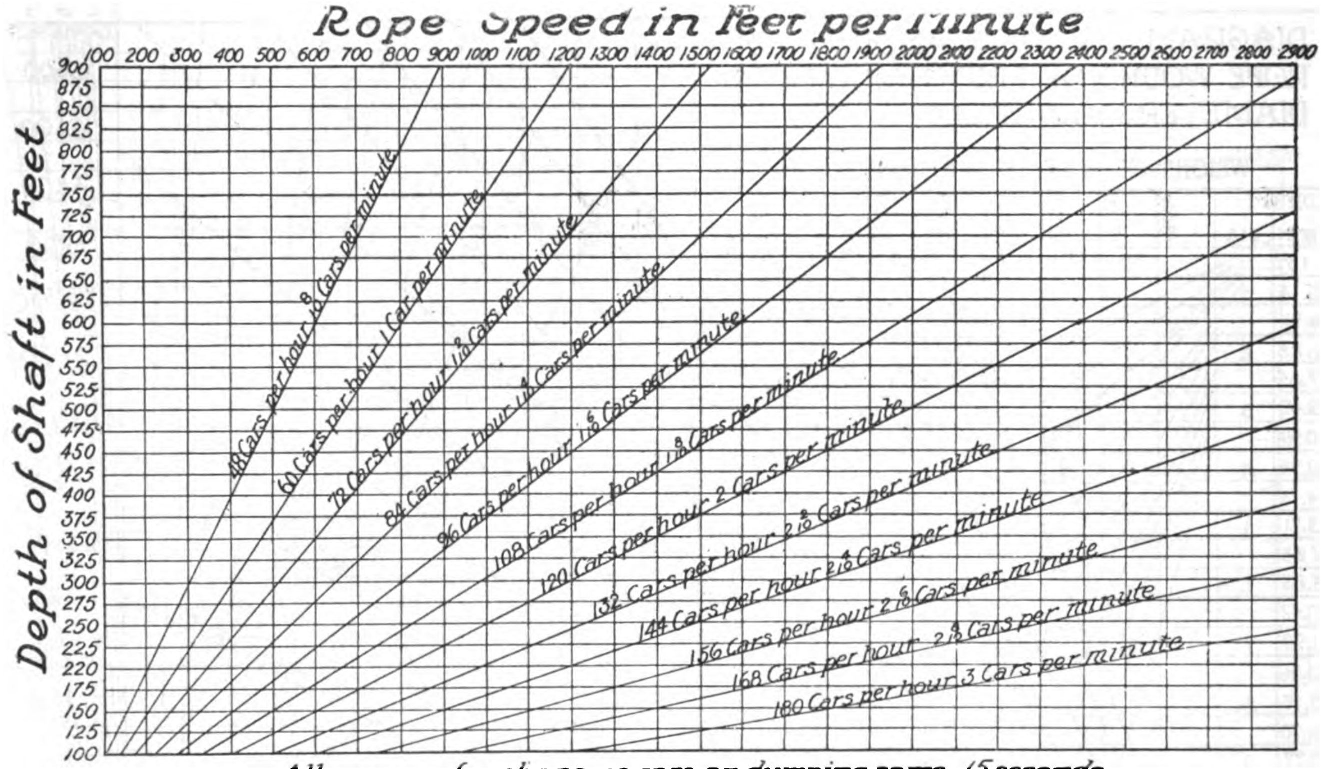
Courtesy Vulcan Iron Works.

Tension on Wire Rope for Incline Planes

At 90°	the tension on rope is	2,000	lbs. for 2,000 lbs. load.
“ 80°	“ “ “ “ “	1,970	“ “ “ “ “
“ 70°	“ “ “ “ “	1,880	“ “ “ “ “
“ 60°	“ “ “ “ “	1,732	“ “ “ “ “
“ 50°	“ “ “ “ “	1,552	“ “ “ “ “
“ 45°	“ “ “ “ “	1,414	“ “ “ “ “
“ 42½°	“ “ “ “ “	1,350	“ “ “ “ “
“ 40°	“ “ “ “ “	1,286	“ “ “ “ “
“ 37½°	“ “ “ “ “	1,216	“ “ “ “ “
“ 35°	“ “ “ “ “	1,148	“ “ “ “ “
“ 32½°	“ “ “ “ “	1,074	“ “ “ “ “
“ 30°	“ “ “ “ “	1,000	“ “ “ “ “
“ 27½°	“ “ “ “ “	922	“ “ “ “ “
“ 25°	“ “ “ “ “	846	“ “ “ “ “
“ 22½°	“ “ “ “ “	764	“ “ “ “ “
“ 20°	“ “ “ “ “	684	“ “ “ “ “
“ 17½°	“ “ “ “ “	600	“ “ “ “ “
“ 15°	“ “ “ “ “	518	“ “ “ “ “
“ 12½°	“ “ “ “ “	432	“ “ “ “ “
“ 10°	“ “ “ “ “	348	“ “ “ “ “
“ 8°	“ “ “ “ “	278	“ “ “ “ “
“ 7°	“ “ “ “ “	242	“ “ “ “ “
“ 6°	“ “ “ “ “	208	“ “ “ “ “
“ 5°	“ “ “ “ “	174	“ “ “ “ “
“ 4°	“ “ “ “ “	138	“ “ “ “ “
“ 3°	“ “ “ “ “	104	“ “ “ “ “
“ 2°	“ “ “ “ “	70	“ “ “ “ “
“ 1°	“ “ “ “ “	34	“ “ “ “ “

A grade of	1	foot in 100 feet equals	¾°	or 45′
“ “ “	2	feet “ “ “ “	1⅙°	“ 1°-10′
“ “ “	2½	“ “ “ “ “	1½°	“ 1°-30′
“ “ “	3	“ “ “ “ “	1¾°	“ 1°-45′
“ “ “	3½	“ “ “ “ “	2°	
“ “ “	4	“ “ “ “ “	2⅓°	
“ “ “	5	“ “ “ “ “	3°	
“ “ “	6	“ “ “ “ “	3½°	
“ “ “	7	“ “ “ “ “	4°	
“ “ “	8	“ “ “ “ “	4¾°	
“ “ “	10	“ “ “ “ “	5¾°	
“ “ “	12¼	“ “ “ “ “	7°	
“ “ “	14	“ “ “ “ “	8°	
“ “ “	16	“ “ “ “ “	9°	
“ “ “	18	“ “ “ “ “	10 1/10°	
“ “ “	20	“ “ “ “ “	11 1/3°	
“ “ “	23	“ “ “ “ “	13°	
“ “ “	25	“ “ “ “ “	14°	
“ “ “	26¾	“ “ “ “ “	15°	
“ “ “	30½	“ “ “ “ “	17°	
“ “ “	36	“ “ “ “ “	20°	(19°-40′)
“ “ “	46½	“ “ “ “ “	25°	
“ “ “	57¾	“ “ “ “ “	30°	
“ “ “	75	“ “ “ “ “	35°	
“ “ “	84	“ “ “ “ “	40°	
“ “ “	100	“ “ “ “ “	45°	

Courtesy Hazard Mfg. Co.



Allowance for changing cars or dumping same =15 seconds.

Cars per Hour

Assume that the shaft is 475 feet deep. We have found that the engines in question will give an average rope speed of 1,890 feet per minute, say 1,900 feet. By referring to this chart it will be readily seen that from a shaft 475 feet deep we can get out two car per minute, or 120 cars per hour. This chart is based on an allowance of one quarter of a minute for changing cars and a double compartment shaft.

Courtesy Vulcan Iron Works.

Bending and Safe Working Stresses for Cast Steel Ropes (19 Wires) Running on Sheaves and Drums of Various Diameters.

(Safe Stress taken one-third of Ultimate Stress.)

Size.	Safe stress.	120″		96″		72″		48″		36″		30″		24″	
		Bending	Working	Bending	Working	Bending	Working	Bending	Working	Bending	Working	Bending	Working	Bending	Working
⅜″	3333	283	3050	353	2980	469	2864	698	2635	924	2409	1102	2231	1366	1967
½″	5867	733	5134	913	4954	1212	4655	1800	4067	2376	3491	2829	3038	3495	2372
⅝″	9067	1506	7561	1876	7191	2485	6582	3680	5387	4847	4220	5759	3308	7095	1972
¾″	12933	2534	10399	3153	9780	4173	8760	6165	6768	8101	4832	9609	3324	11807	1126
⅞″	17333	3943	13390	4886	12447	6481	10852	9556	7777	12528	4805	14835	2498		
1″	22667	6059	16608	7528	15139	9937	12730	14614	8053	19113	3554	22589			
1⅛″	28000	8474	19526	10523	17477	13872	14128	20357	7643	26556	1444				
1¼″	33333	11452	21881	14209	19124	18713	14620	27400	5933						
1⅜″	41333	15545	25788	19272	22061	25350	15983	37028							
1½″	48000	19906	28094	24662	23338	32403	15597								
1⅝″	56000	25005	30995	30957	25043	40629	15371								
1¾″	64000	31689	32311	39203	24797	49919	14081								
2″	82667	46285	36382	57183	25484	74795	7872								

By Courtesy of the Lehigh and Wilkes-Barre Coal Co.

WIRE ROPE DATA

Mining Rope Arrangements

For vertical shaft work it is customary to use almost universally the 6x19 construction rope. The cages are usually arranged in pairs so that as one is lowered the other is raised this being known as the balanced hoist system. Two types of hoisting drums are in common use, the flat drum and the conical drum, the latter being designed to give a slower starting speed when the cage is lifted from the bottom of the mine.

The simplest arrangement is for the ropes to pass directly from the drum to two head sheaves carried on a wooden or steel tower, each sheave lined with the center of that part of the drum on which the rope has to wind. It is customary with either the flat or conical drum to attach one rope to the under side of the drum and the other rope to the top of the drum, leaving several turns on the drum when the cage is resting on the bottom of the mine shaft. The names "underwind" and "overwind" are applied to these two ropes.

Conical drums are used more frequently on shorter mine ropes, but unless the smaller end has nearly as large a diameter as would be used for a flat drum, the rope service may not be much better than with a flat drum. It is a debatable point as to which type of drum is the better.

Crucible Cast Steel Hoisting Rope

Standard Strengths, Adopted May 1, 1910

6 Strands—19 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Approximate Weight per Foot in Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Diameter of Drum or Sheave in Feet Advised
2¾	8⅝	11.95	211	42.2	11
2½	7⅞	9.85	170	34	10
2¼	7⅛	8	183	26.6	9
2	6¼	6.30	106	21.2	8
1⅞	5¾	5.55	96	19	8
1¾	5½	4.85	85	17	7
1⅝	5	4.15	72	14.4	6.5
1½	4¾	3.55	64	12.8	6
1⅜	4¼	3	56	11.2	5.5
1¼	4	2.45	47	9.4	5
1⅛	3½	2	38	7.6	4.5
1	3	1.58	30	6	4
⅞	2¾	1.20	23	4.6	3.5
¾	2¼	.89	17.5	3.5	3
⅝	2	.62	12.5	2.5	2.5
9/16	1¾	.50	10	2	2.25
½	1½	.89	8.4	1.68	2
7/16	1¼	.80	6.5	1.30	1.75
⅜	1⅛	.22	4.8	.96	1.50
5/16	1	.15	3.1	.62	1.25
¼	¾	.10	2.2	.44	1

We recommend wherever possible that installations of mine hoist ropes be made with as few bends as possible. In case a shaft has to be changed or if the engine room cannot be located, so as to carry the rope, a turn sheave may be used with suitalbe lead and intermediate supporting sheaves to carry the rope.

Plow Steel Hoisting Rope

Standard Strengths, Adopted May 1, 1910

6 Strands—19 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Approximate Weight per Foot in Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Diameter of Drum or Sheave in Feet Advised
2¾	8⅝	11.95	275	55	11
2½	7⅞	9.85	229	46	10
2¼	7⅛	8	186	37	9
2	6¼	6.3	140	28	8
1⅞	5¾	5.55	127	25	8
1¾	5½	4.85	112	22	7
1⅝	5	4.15	94	19	6.5
1½	4¾	3.55	82	16	6
1⅜	4¼	3	72	14	5.5
1¼	4	2.45	58	12	5
1⅛	3½	2	47	9.4	4 5
1	3	1.58	38	7.6	4
⅞	2¾	1.20	29	5.8	3.5
¾	2¼	.89	23	4.6	3
⅝	2	.62	15.5	3.1	2.5
9/16	1¾	.50	12.3	2.4	2.25
½	1½	.39	10	2	2
7/16	1¼	.30	8	1.6	1.75
⅜	1⅛	.22	5.75	1.15	1.50
5/16	1	.15	3.8	.76	1.25
¼	¾	.10	2.65	.53	1

Extra Strong Crucible Cast Steel Hoisting Rope

Standard Strengths, Adopted May 1, 1910

6 Strands—19 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Approximate Weight per Foot in Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Diameter of Drum or Sheave in Feet Advised
2¾	8⅝	11.95	243	48.6	11
2½	7⅞	9.85	200	40	10
2¼	7⅛	8	160	32	9
2	6¼	6.3	123	24.6	8
1⅞	5¾	5.55	112	22.4	8
1¾	5½	4.85	99	19.8	7
1⅝	5	4.15	83	16.6	6.5
1½	4¾	3.55	73	14.6	6
1⅜	4¼	3	64	12.8	5.5
1¼	4	2.45	53	10.6	5
1⅛	3½	2	43	8.6	4.5
1	3	1.58	34	6.80	4
⅞	2¾	1.20	26	5.20	3.5
¾	2¼	.89	20.2	4.04	3
⅝	2	.62	14	2.80	2.5
9/16	1¾	.50	11.2	2.24	2.25
½	1½	.39	9.2	1.84	2
7/16	1¼	.30	7.25	1.45	1.75
⅜	1⅛	.22	5.30	1.06	1.50
5/16	1	.15	3.50	.70	1.25
¼	¾	.10	2.48	.49	1

Courtesy American Steel & Wire Co.

WIRE ROPE DATA

Mine haulage systems are very widely different one from another, so much so that it may almost be said that there are hardly any two alike. At the same time there are in common use three leading systems known respectively as

1. **Endless Haulage Rope System.**
2. **Tail Rope System.**
3. **Gravity Inclined Plane.**

1. The endless system consists of a wire rope usually 6x7 construction, spliced endless with small cars gripped on to the rope at regular intervals either singly or in groups of two or three. Two kinds of drum driving arrangements are usually employed known as the elliptical and the figure 8 style respectively. The elliptical arrangement is preferable to the figure 8 as the rope in the latter case is subjected to reverse bending on the drums. Suitable slip rings should always be used on drums to equalize the tension of the different winds of rope, and a tension carriage with counterweight is also necessary. Position of engine and driving drums is usually dependent upon the location of pit mouth. Slow speed of about 3 to 4 miles per hour is the average of this system.

2. Tail rope systems consist of two ropes known respectively as head line and tail line, the latter usually being about double the length of the former. Each rope is carried upon a separate drum and it differs from the endless system in that its operation is intermittent and the cycle of operations is for the head line to pull out a trip of about fifty loaded cars at a speed of about ten miles per hour. The time taken for the trip is dependent upon the length of the headline. The tail line is always attached to the rear car of the trip and as soon as the loaded cars have run to the tipple by gravity, an empty trip of cars is pulled back into the mine by the tail line while the head line is at the same time attached to the front end of the train. The train of loaded cars or empty cars as the case may be, is thus always under perfect control whether coming from the mine or returning to it.

Plow Steel
Transmission, Haulage or Standing Rope

Standard Strengths, Adopted May 1, 1910

6 Strands—7 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Approximate Weight per Foot in Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Diameter of Drum or Sheave in Feet Advised
1½	4¾	3.55	82	16.4	11
1⅜	4¼	3	72	14.4	10
1¼	4	2.45	60	12	9
1⅛	3½	2	47	9.4	8
1	3	1.58	38	7.6	7
⅞	2¾	1.20	31	6.2	6
¾	2¼	.89	23	4.6	5
11/16	2⅛	.75	18	3.6	4¼
⅝	2	.62	16	3.2	4½
9/16	1¾	.50	12	2.4	4
½	1½	.39	10	2	3½
7/16	1¼	.30	7	1.4	3
⅜	1⅛	.22	5.9	1.2	2¾
5/16	1	.15	4.4	.88	2¼
9/32	⅞	.12½	3.4	.68	1¾

Crucible Cast Steel Transmission, Haulage or Standing Rope

Standard Strengths, Adopted May 1, 1910

6 Strands—7 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Approximate Weight per Foot in Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Diameter of Drum or Sheave in Feet Advised
1½	4¾	3.55	63	12.6	11
1⅜	4¼	3	53	10.6	10
1¼	4	2.45	46	9.2	9
1⅛	3½	2	37	7.4	8
1	3	1.58	31	6.2	7
⅞	2¾	1.20	24	4.8	6
¾	2¼	.89	18.6	3.7	5
11/16	2⅛	.75	15.4	3.1	4¼
⅝	2	.62	13	2.6	4½
9/16	1¾	.50	10	2	4
½	1½	.39	7.7	1.5	3½
7/16	1¼	.30	5.5	1.1	3
⅜	1⅛	.22	4.6	.92	2¾
5/16	1	.15	3.5	.70	2¼
9/32	⅞	.12½	2.5	.50	1¾

Extra Strong Crucible Cast Steel Transmission, Haulage or Standing Rope

Standard Strengths, Adopted May 1, 1910

6 Strands—7 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Approximate Weight per Foot in Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Diameter of Drum or Sheave in Feet Advised
1½	4¾	3.55	73	14.6	11
1⅜	4¼	3	63	12.6	10
1¼	4	2.45	54	10.8	9
1⅛	3½	2	43	8.6	8
1	3	1.58	35	7	7
⅞	2¾	1.20	28	5.6	6
¾	2¼	.89	21	4.2	5
11/16	2⅛	75	16.7	3.3	4¼
⅝	2	.62	14.5	2.9	4½
9/16	1¾	50	11	2.2	4
½	1½	.39	8.85	1.8	3½
7/16	1¼	.30	6.25	1.25	3
⅜	1⅛	.22	5.25	1 05	2¾
5/16	1	.15	3.95	.79	2¼
9/32	⅞	12½	2.95	59	1¾

Courtesy American Steel & Wire Co.

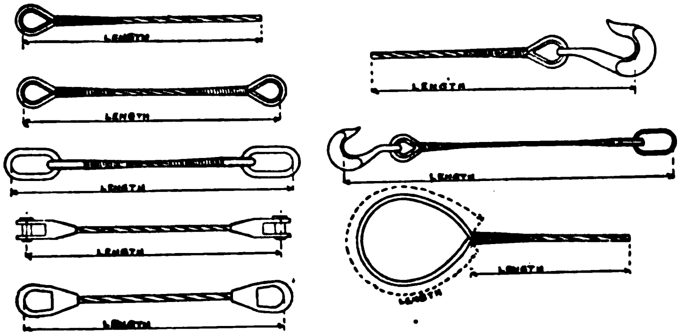
How to Order Wire Rope

State length, size, diameter (or circumference), quality, number of strands, number of wires in the strand, and whether hemp center or wire center is wanted, also whether bright or galvanized is desired, e. g., 750 feet long, 1⅛ inches in diameter, plow steel hoisting rope, six strands, nineteen wires, hemp center, one piece.

If rope is to be equipped with thimbles, sockets, hooks, links, loops or other fittings, state the length from the pull of thimble, socket, hook, link, loop, etc., to end of the rope. Where fittings are to be put on each end, be sure and state the length from pull to pull of fittings.

If in doubt as to the material to be used, the conditions under which the rope operates should be given or a sample of rope that is satisfactory submitted so that the proper quality and construction may be furnished.

If possible, submit a rough sketch with the order, or inquiry showing the size and relative position of the sheaves, together with the figures of maximum load in pounds. This greatly facilitates a complete understanding of the requirements which the rope must fill.



Inspection, Care, Lubrication And Handling Of Wire Rope

As a rule, mining companies carry spare ropes on hand which should be stored in a thoroughly dry place. If they are put in a damp place, or left exposed to the weather, they will be more or less injured, unless the rope is thoroughly lubricated, and even in this case it is far better policy to have the rope well protected.

Hoisting and haulage ropes are shipped on reels and unwinding is a simple matter. If the reel is heavy, a large diameter pipe may be passed through its center, which will then serve as an axis. Each end of the pipe is then rested on a brace, or other support, at such a height that the reel is lifted off the ground and is free to turn about its center. Ropes of shorter lengths are sometimes received in a coil and great care must be taken to prevent kinks in unwinding. The rope should be rolled along the ground like a hoop, and under no consideration should be taken off coil by coil.

A rope should be carefully inspected when it is installed in order to determine whether or not it has been injured in transit, and, moreover, for the purpose of detecting imperfections in manufacture. Manufacturers would much rather be advised of anything of this description than to have the rope installed and complaints made afterwards.

Hoisting ropes should be examined daily, especially where men are brought in or out of the mine. In most states this examination is made compulsory. Frictional wear and corrosion externally, along with abrasion of the wires and deterioration of the core internally, due to use and conditions, are continually taking place. When this wear has progressed to such an extent that the cross sections of the wires are reduced and their strength materially lessened, broken wires begin to appear along its surface. As wearing continues, the number of breaks increases. This is a sure indication of the diminished strength of the rope, since the broken wires are the result of the weakened condition.

As long as the breaks are far apart, little effect is produced on the strength of the rope, since the frictional tenacity is not impaired by a few breaks far removed from each other. But when several breaks occur close together, the strength is much more affected. It will thus be seen that the number of breaks in the rope and the relation they bear to each other provides an index of the safe condition of the rope.

All ropes should be lubricated, and in wet shafts the rope should be well protected from the entrance of moisture. In some instances ordinary black oil is used. This has little or no value, as it does not cling to the surface, penetrate to the core, nor resist the effects of moisture or other damaging elements. An efficient wire rope lubricant must be free from any material that will attack the constituent parts of the rope, must remain soft and pliable under all atmospheric conditions, and must not be subject to evaporation. It must be insoluble in water and must be unaffected by the acids contained in mine water. It must, moreover, have the property of penetration, enabling it to reach every wire and each strand into the core. It must have great adhesiveness and must not peel.

As a general rule, hoisting ropes give out at a point near the socket. As the slack is taken up at the beginning of hoisting there is considerable vibration, and as the length of rope constantly diminishes during the hoist, the effects of this swaying of the rope are concentrated at or about the socket. Crystallization of the wires takes place, and in order to eliminate this weakened section a portion of the rope should be cut off at regular intervals. Wire ropes will always stretch after being put into service, and unless ample provision is made at the cage connections for taking up the increase in length, the excess may have to be taken up on the drum or else the rope cut and re-socketed.

ALLIS-CHALMERS MFG. CO.

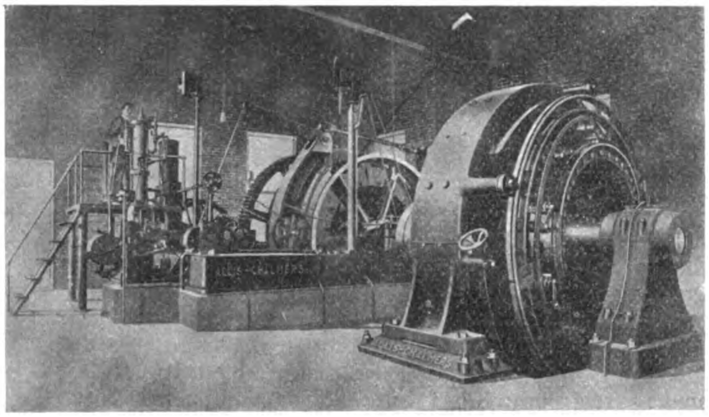
MILWAUKEE, WISCONSIN

Branch Offices in All Principal Cities

Steam and Electric Hoists

Products

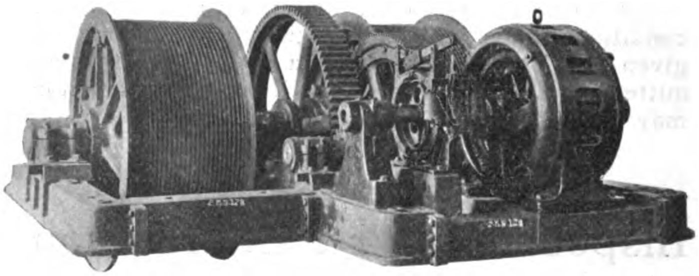
Electrical Hoists, Steam Hoists, Power Transmission Machinery, Coal Crushing Rolls, Crushers and Pulverizers, Hoist Cages, Revolving and Shaking Screens.


20,300 lbs. Rope Pull 1660 ft. per minute Electric Hoist built for Peabody Coal Co., Chicago, Ill.

The Allis-Chalmers Manufacturing Company, having a wider experience than any other manufacturer in the successful design and operation of Mining Machinery, has had an unusual opportunity to obtain a comprehensive knowledge of all operating conditions to be met in hoisting engineering. Being also one of the largest manufacturers of electrical apparatus, its experience in this line has given it a thorough knowledge of the difficulties to be met and overcome in adopting electric power to the operation of hoists.

This Company extends the services of its Engineering Department to recommend the proper type of hoist to be used.

A complete line of single drum motor driven hoists is built in capacities ranging from 2,000 pounds rope pull to 7,000 pounds rope pull and the small double drum hoist 3,500 pounds rope pull and 7,000 pounds.

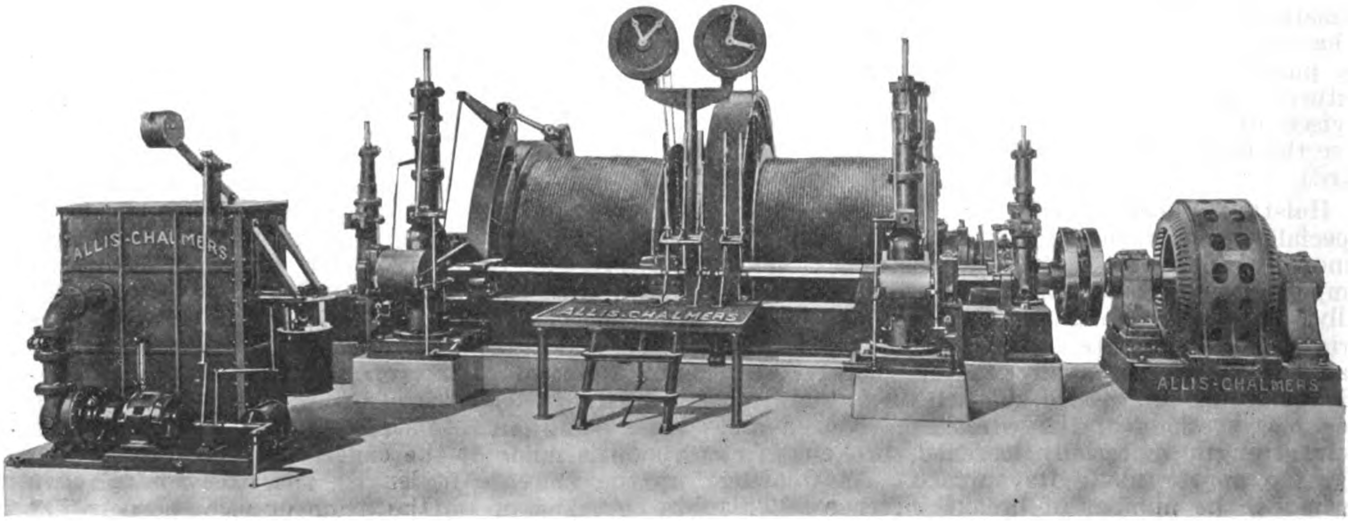

24,000 lbs. Rope Pull 375 ft. Rope Speed double drum Automatic Electric Hoist.

The larger hoists are built in capacities to meet local conditions. Consult the Company for further information. Bulletin No. 1445 will be sent on request.

Power Transmission Machinery

This Company manufactures a complete line of Power Transmission Machinery, including shafting of all kinds, pulleys, couplings, hangers, bearings, etc. The material and workmanship used in the building of this class of machinery is of the highest grade throughout. We solicit your inquiries. Send for Catalogue No. 133.

This Company manufactures a complete line of coal crushing rolls, shaker screens, revolving screens, pulverizers, crushers, etc., and solicits inquiries for same. Send for Catalogues Nos. 1412-A and 1411.



17,000 lbs. Rope Pull 650 ft. per minute Rope Speed double drum Electric Hoist.

CHERRY TREE MACHINE COMPANY

CHERRY TREE, PA.

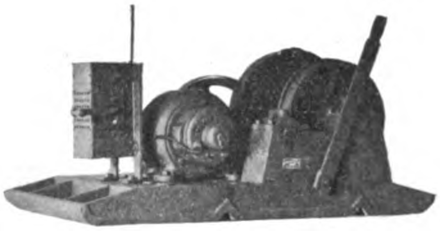
Manufacturers of:—

"Brownie" Hoists.
Mine Cars of all descriptions.
"Ring Oiler" Mine Car Wheels.
Rope Sheaves, Grate Bars and Brake Shoes.
Mining Machine Parts.
General Iron and Brass Castings.

THE BROWNIE HOIST

A portable Electric Hoist built especially for hauling mine cars in Rooms or Headings that are on a grade, or for hoisting light loads.

Use:—To eliminate, what is very often a just cause for complaint by the Miner;—the pushing of Mine Cars on heavy grades.



Specifications:

Rope Drum—Capacity 1000 ft. of $\frac{3}{8}''$ or 700 ft. of $\frac{1}{2}''$ wire rope.

Motor—Any standard make AC or DC can be furnished. Standard equipment is a 5HP—30-minute rating series—shunt elevator type motor.

Gearing, Etc.—Double reduction spur gears, cut forged Steel pinion. Automobile type band brake.

Dimensions—Width 30″, Length 60″, Height 28″, Weight 1400 lbs.

Performance

The Brownie Hoist will give a rope pull of 1500 pounds at a speed of 125 feet per minute.

ELECTRICAL EQUIPMENT

We are representatives for and can furnish expert engineering advice on:

Crocker-Wheeler Co. Motors and Generators.
Detroit Fuse & Mfg. Co.—Enclosed Switches.
Stimple & Ward Co.—Electrical Repairing.

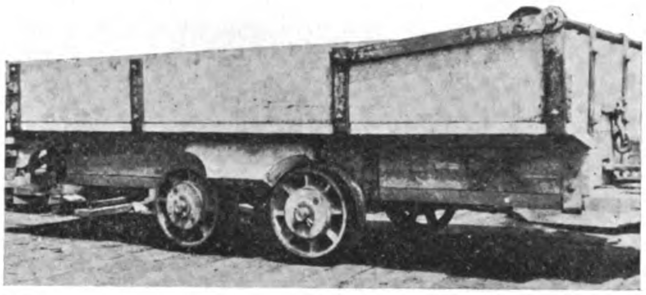
Sales Engineers for:—

Small Motors.
Electrical Repairing.
Automatic Controllers.
Enclosed Switches.

MINE CARS

Kinds:—Wood or composite, according to design submitted.

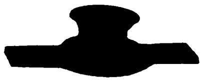
Trucks:—We recommend our "Cherry Tree" riveted bar truck with boxings. It is as light as possible, consistent with strength and assures permanent alignment of the axles.



Wheels:—We recommend our Special "Ring Oiler." The Oil ring is cast inside the oil reservoir and rides on the hub, feeding oil to the axle through an opening in the inner hub. This system of oiling assures continuous lubrication and greatest economy of lubricant. All wheels are made from special analysis iron, and are deeply chilled and carefully annealed.

CASTINGS

We make a specialty of all kinds of Iron or Brass Castings for mine use, such as Brake Shoes, Grate Bars, Frogs, Door Liners, Sheaves, Gears, etc., and are able to offer prompt and careful service on all special machine parts or repair work.



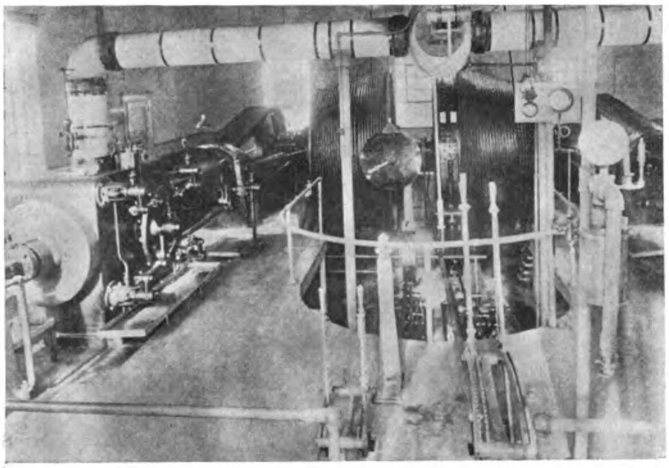
The sheave and base illustrated is a special design suited particularly for use with the "Brownie" Hoist.

Connellsville Mfg. & Mine Supply Co.

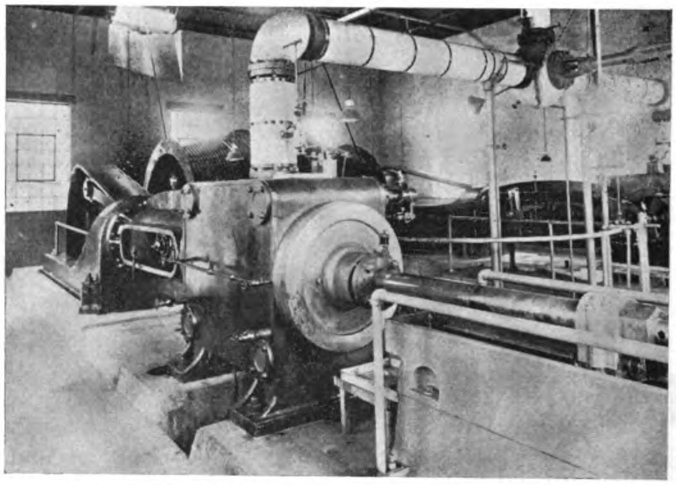
Main Office and Works
CONNELLSVILLE, PA.
Brown-Marx Building, Birmingham, Ala.
Designers and Builders of

Steam and Electric Hoists

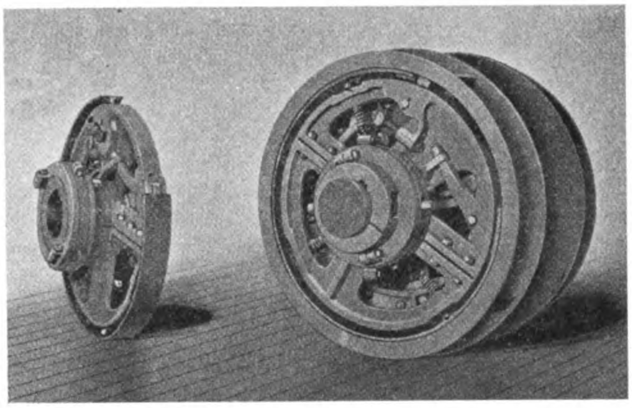
Our Reputation:—Strength—Durability—Service.



26 x 48" First Motion, Double Conical Drum, Shaft Hoisting Engine, of the four valve Corliss type; equipped with the Lepley Patent Safety Stop Mechanism. Ask for Safety Bulletin No. 88.



26 x 48" First Motion, Double Conical Drum, Shaft Hoisting Engine. A modern, high class Hoist, embodying all of the best features of design and construction.



Lepley Patent Band Friction Clutch

The friction band is fibre lined, internal expanding, with such simple, efficient and safe means for its application and adjustment that there is nothing found on the market to equal it where hard and exacting service is demanded. It is easily operated by a hand mechanism. When fully applied it will hold itself on and leave no end thrust on either the shaft or the clutch. When released, the band has free and equal running clearance all round.

Lepley's Patent Safety Stop for Hoisting Engines

This apparatus has seven distinct and separate functions:

First.—It automatically and positively slows down the engine every time the rising cage is nearing its landing, so that it will bring the cage to a stop from 3 to 4 feet above the landing, if the engineer should not touch the throttle at all.

Second.—If the engineer should neglect or forget to close the throttle and apply the brake by hand to stop the engine at the right time, the emergency trip will do it for him, when the cage has risen from 3 to 4 inches above the landing, and will stop the engine almost instantly.

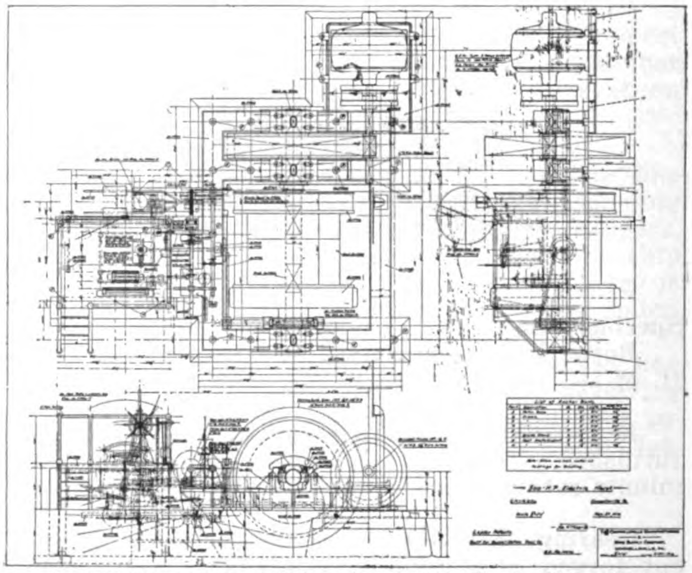
Third.—It will prevent the engineer from releasing the brake or moving the reverse lever off the center, or getting steam into the engines until the trip is reset.

Fourth.—When the trip is hooked up into the operating position, and either cage at the top landing, it will prevent the engineer from moving the operating levers in the wrong direction.

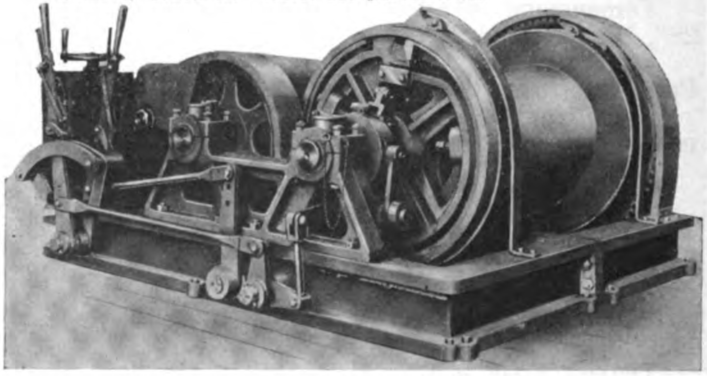
Fifth.—It enables the engineer to instantly adjust the brake at any time, by means of a hand lever.

Sixth.—It prevents the engineer from lowering the men to the shaft bottom fast enough to hurt them.

Seventh.—Where self dumping cages are used for hoisting to a dumping level, and also for hoisting men from the mine to a lower level, it positively prevents the engineer, after getting the signal to hoist men, from hoisting them to the dumping level and hurting them.



A Modern, single, friction drum, 500 H. P. Slope Hoist installed at one of the mines of the Consolidation Coal Co., in Penna., equipped with all of the latest automatic, regulating and safety features. Write for particulars.



Our standard type of single friction drum Entry Hoist for 60 to 75 H. P. motors. Built in many sizes and equipped with the Lepley Patent Internal Expansion Band Friction Clutches, hand operated, double brakes and steel cut gears.

Favor us with your Hoist Problems and they will have immediate and intelligent attention.

The Connellsville Mfg. & Mine Supply Co.

Main Office and Works
CONNELLSVILLE, PA.
Brown-Marx Building, Birmingham, Ala.

The Cage Builders and Manufacturers of Special Mine and Coke Works Equipment

Our many satisfied customers will tell you of the superior merits of the Lepley Patent, Self-Dumping and Platform Cages, which we build for every variety of service.

We will be pleased to give you full information on our steel wedge safety dogs, safety locks and automatic caging features on application.

Lepley's Patent Safety Cage

Figures 1 and 2 show Lepley's Safety Self-Dumping Cage. This cage was developed to replace the old style, less safe, less reliable types of self-dumping cages, and to meet the demand for larger tonnage, heavier loads, higher speeds and greater security.

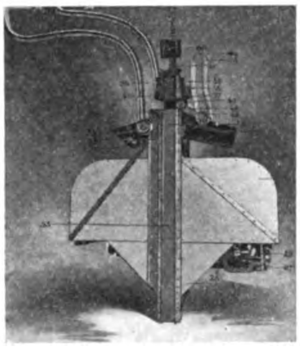


Fig. 1, Showing Side View of New Self Dumping Cage Tipping Mechanism.

It will hoist and dump four wagons of coal, of three tons each per minute, a distance of 400 feet, without difficulty and without mishap.

The descending cage, as it lands on the shaft bottom, automatically releases the empty car, and the loaded car on entering, automatically spots and so securely locks itself on the cage, before it starts to rise, that it cannot be dislodged while traveling in the shaft or while dumping, and this without the aid of any special attachment on the car or car track.

By means of a hand lever, easily operated, the car can be released for removal and replacement at the surface landing, without the aid of any landing dogs or seats.

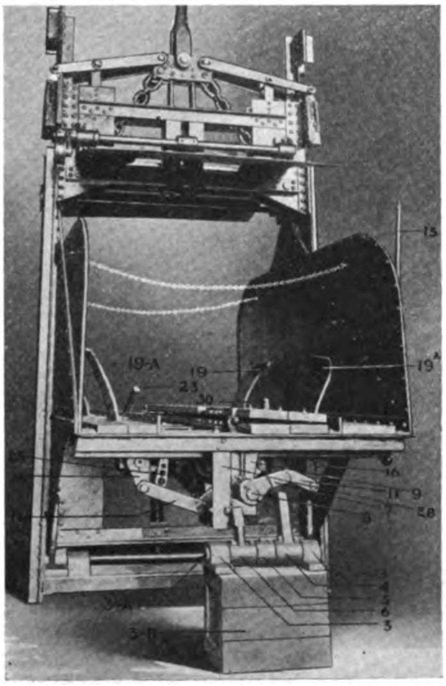


Fig. 2, Showing Front End of New Self Dumping Cage with Horns Open.

The tilting member of the cage, as it enters the dumping point, is automatically released from the bail, or lifting member, before the dumping cycle begins, and is permanently locked again against release before it descends into the shaft. In case of a rope or hitching failure, it will always and positively stop at the point in the shaft where the failure occurs.

The Lepley Cager

The Lepley Cager is a heavy, ruggedly built, steel, self-contained structure containing foundation bases, heavy track rails and automatic mechanism for stopping and caging mine cars at the bottom of a hoisting shaft, or for automatically stopping and admitting mine cars into rotary or other car dumps on mine tipples.

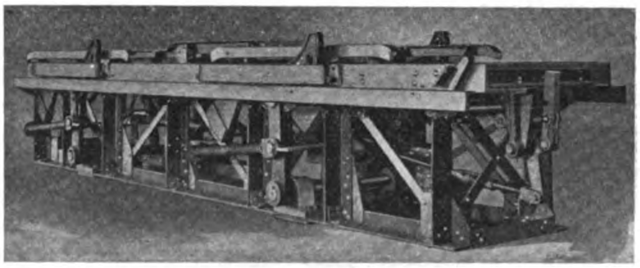


Fig. 3

The Lepley Patent Universal Slate and Rock Dump Car

Will save you a lot of money and trouble in disposing of your refuse. It is motor driven by a trolley. Builds its own fill without trestling ahead, by dumping ahead and on both sides of the track.

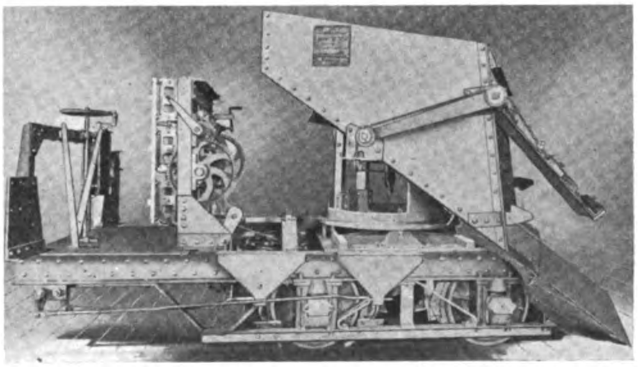


Fig. 4

We build this in 5 and 10 ton capacities. Ask for our Bulletin No. 81 for full particulars.

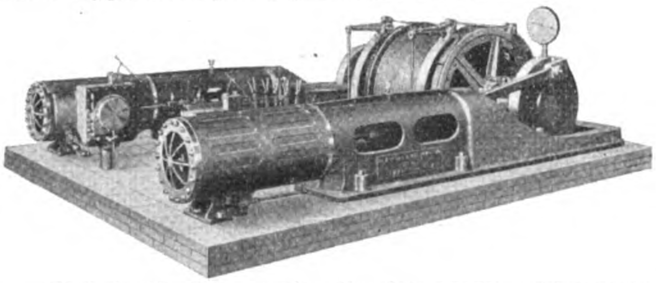
CRAWFORD & McCRIMMON CO.

Established 47 Years.

BRAZIL, INDIANA.

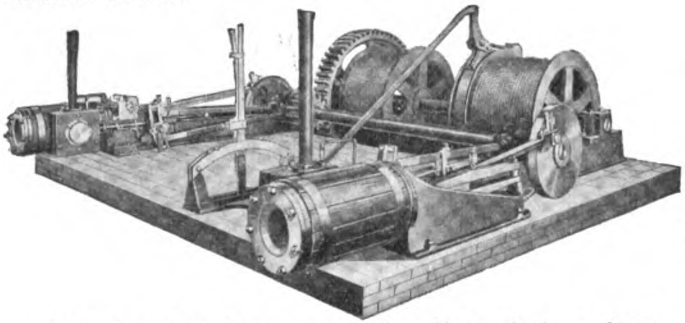
HOISTING AND HAULING ENGINES, FANS, PUMPS AND ELECTRIC HOISTS

New Type Heavy Duty Steam Hoist

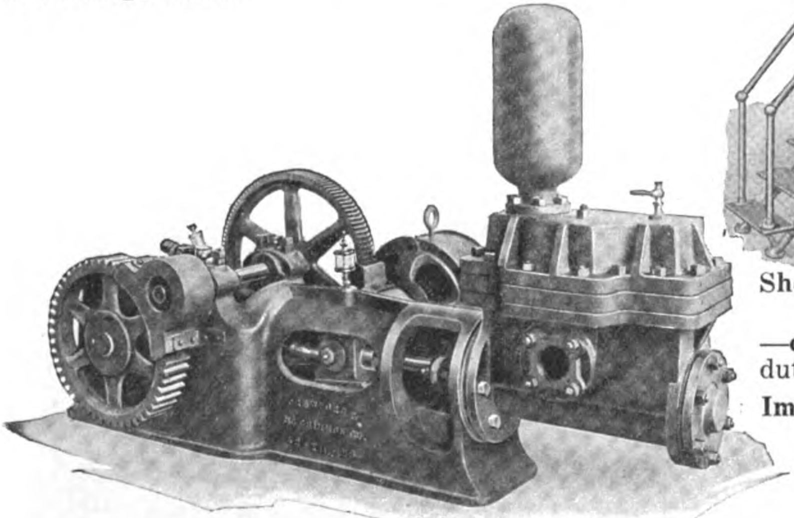


This is the big engine for big work. Has more than a dozen new features, including the stationary links. (Ask the engineer about this). One-piece Bed, Steel Drums, New and Reliable Steam Brake and Reverse, Non-Stick Automatic Throttle.

Geared Hoists



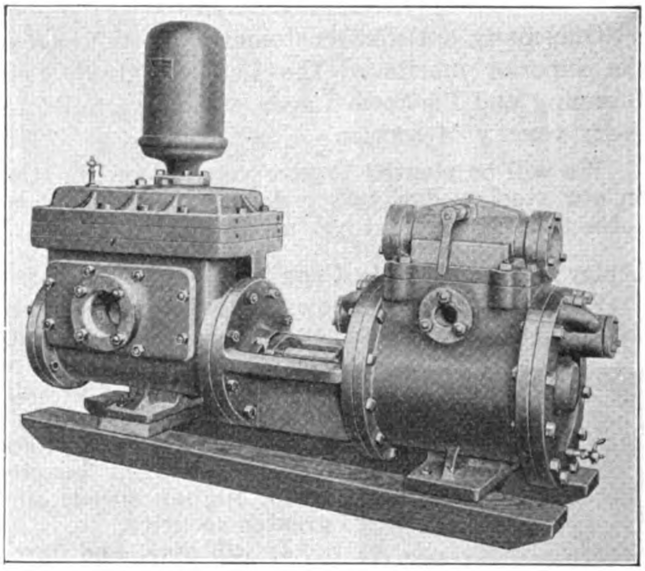
Ask for bulletins. Ask for list of American and foreign users.



Electric Pump. Semi-Steel Cut Gears. Massive Strength. Improved Design.

Modern New Daylight Shops

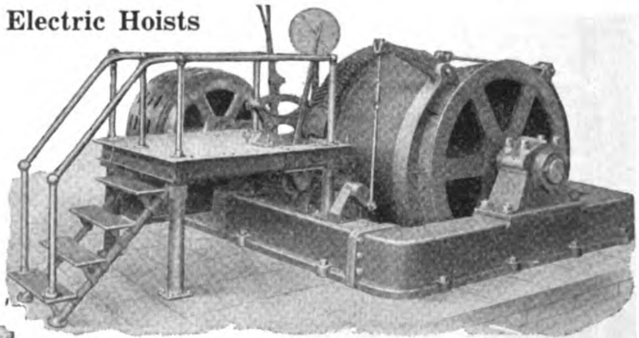
100,000 sq. ft. floor space. New machine tools and equipment. All standardized work.



The Lead Lined Acid-Proof Pump. Original and only builder. Steam and electric.

Not an ordinary pump, and not a "price pump." Best guaranteed pump value offered and proven. Numerous companies use as many as a dozen. Learn why.

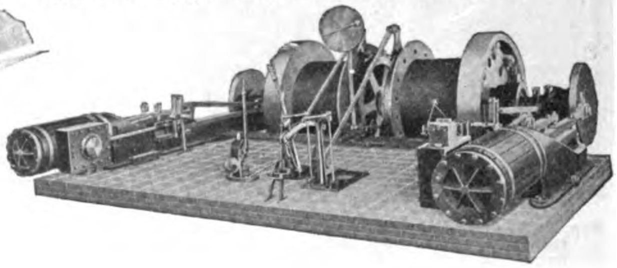
Electric Hoists



Sheave Wheels

We specialize on heavy duty sheave wheels—**chilled rims.** Massive strength for severe duty. Ask for blue prints and estimates.

Improved Type Friction Clutch Hoists



DIAMOND MACHINE CO.

MONONGAHELA, PA.

Manufacturing Engineers

SALES AGENTS

Cooke Wilson Electric Supply Co.
Imperial Power Bldg., Pittsburgh, Pa.

Cooke & Wilson Co.,
Charleston, W. Va.

Products

- Electric Hoists.
- Incline Machinery.
- Sheaves—Cast Iron and Bicycle Type.
- Cages.
- Rope Grips for Endless Haulage.
- Miller Automatic Safety Cage Controlled Gates.

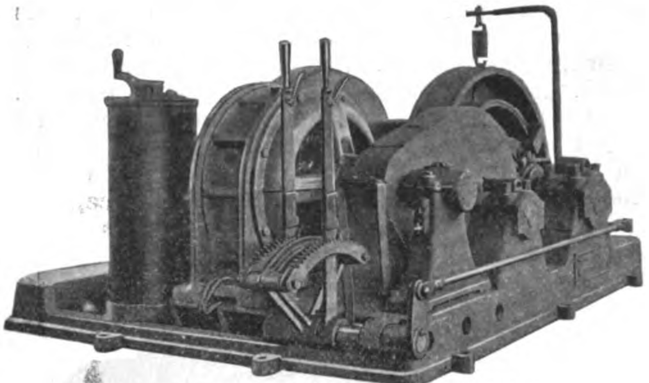


Fig. 112—50 H. P. Supply Incline Hoist.

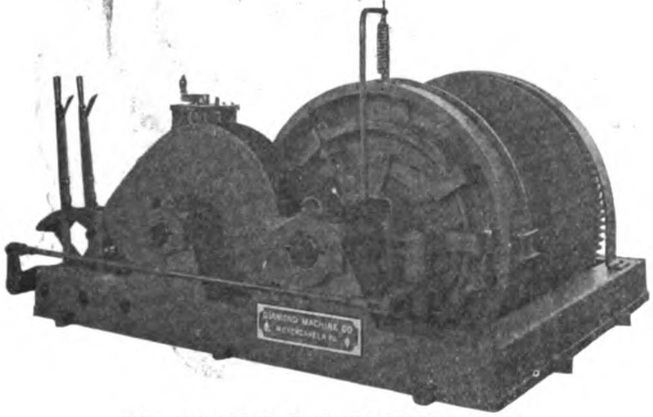
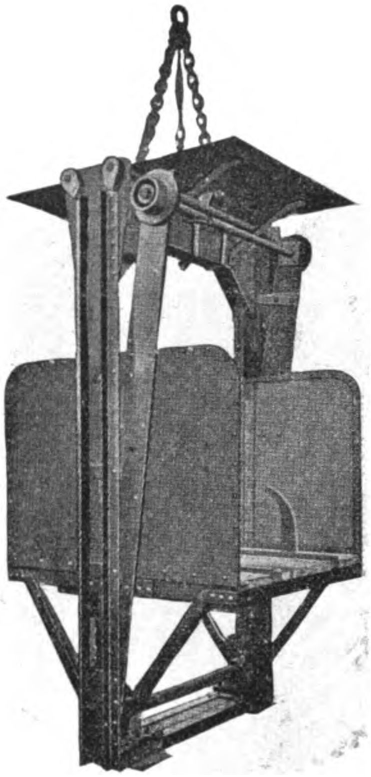
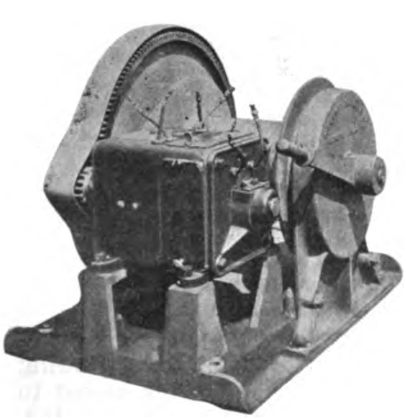


Fig. 115—75 H. P. Band Friction Hoist.



Platform and Self-Dumping Cages.

Electric Hoists for All Classes of Mine Service.



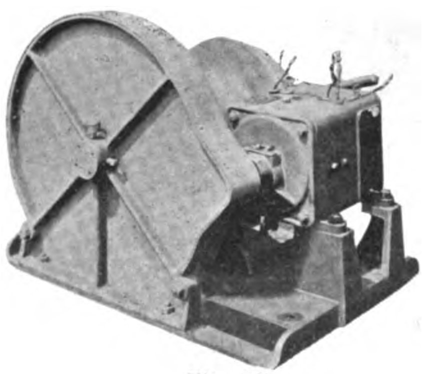
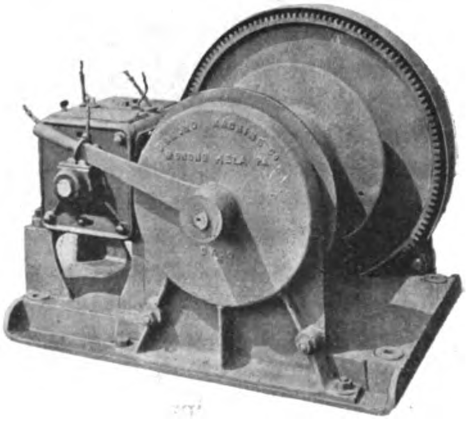


Fig. 325.



Room Hoist

Most compact. Fewest parts. Cone friction and brake operated by one hand lever. No controller to give trouble. Power controlled by simple knife switch. Cast iron bed plate. 5 H. P. motor A. C. and D. C.

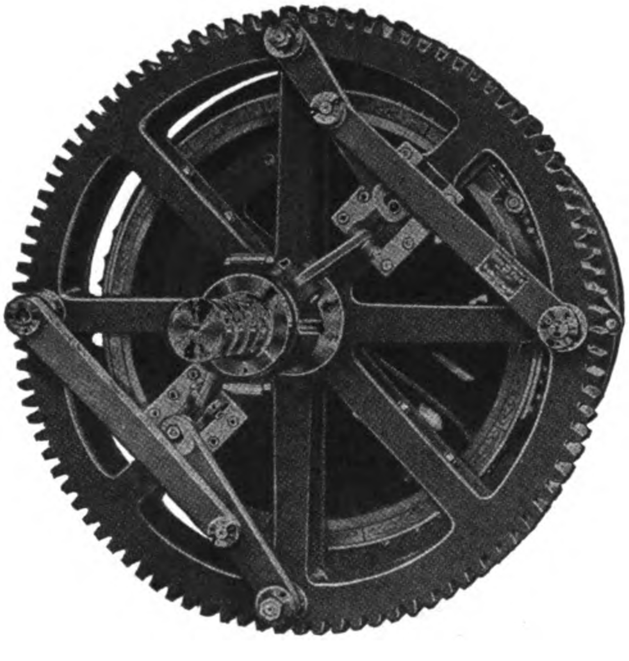
S. FLORY MANUFACTURING CO.

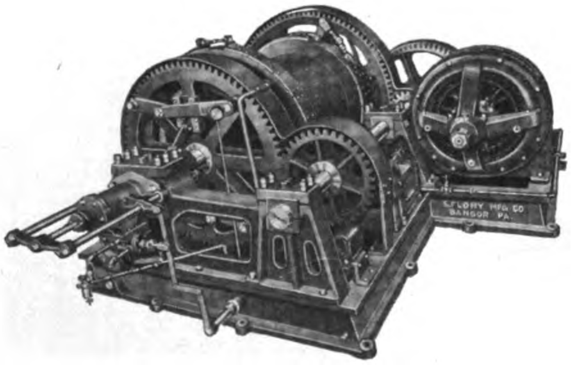
General Office and Works
BANGOR, PENNA.

New York Office
95 LIBERTY STREET

Modern Mine Hoists
Steam--Electric--Air

Since 1878 we have manufactured Mining Hoists to meet all conditions and requirements, using Cone and Band Friction, operated by steam, air or hand. Wood or Asbestos Brakes operated by steam, air or hand. The **Flory Hoist** has never failed. Our guarantee goes with every hoist. Give us an opportunity to submit our prices before you buy.





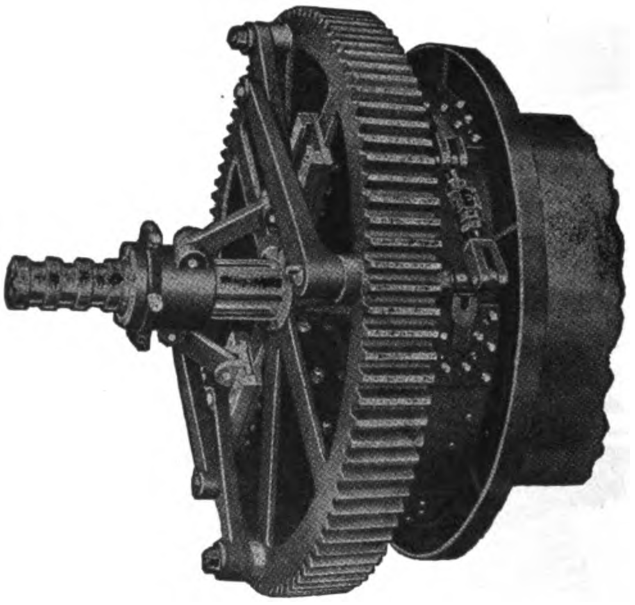
Flory Two Speed Electric Hoist

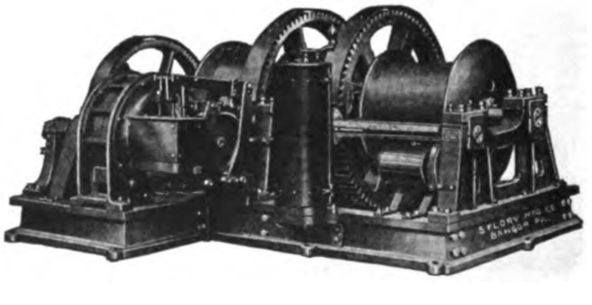
Two Werner (patented) Band Frictions, operated by air. Air equipment, automatic pump, tank, etc., all mounted on the frame of the hoist.

Adaptation—Same as two-speed steam hoist described on opposite page.

The Werner (Patented) Band Friction

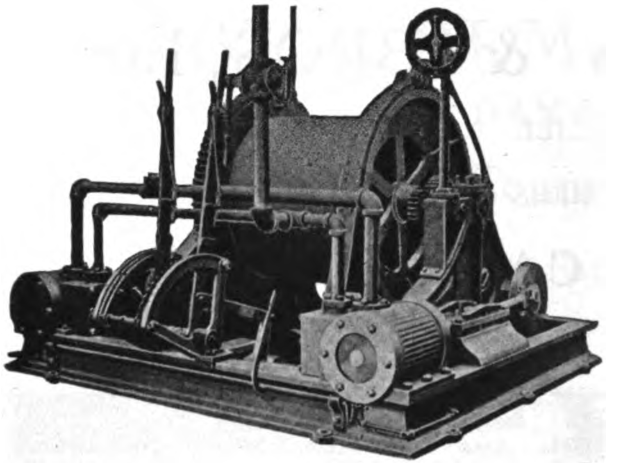
A distinctive feature. Used only on **Flory Hoists.** The Werner Band Friction transmits its load directly from the gear to the Friction Ring on the Drum, thereby eliminating all tortional stress in the Drum Shaft. For simplicity, perfect balance, ease and rapidity of operation and maximum efficiency, it is unexcelled by any other type. It has been tested in the hardest slope and cage operations to perfect satisfaction of the users.





Flory Single Reverse Motor, Double Drum Electric Hoist
with solenoid brake, electric overwinding attachment, preventing the operator from overwinding the cage at either end of shaft. Drums keyed to drum shaft. All gears and pinions well guarded, with heavy steel bands. An ideal double compartment shaft hoist.

We can supply your requirements satisfactorily as well as economically.

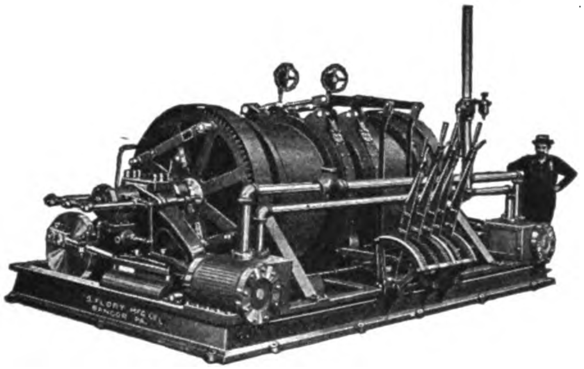


Double Cylinder, Single Drum, Link Motion Engine with Band Brake and Dial Indicator. Especially Adapted for Mines, Incline Planes, Etc.

The drum is keyed fast to the shaft and the hoisting and lowering is done by steam, insuring safety and complete control of all operations. Has one powerful differential brake of wood or asbestos.

TABLE OF SIZES, ETC.

Size Number of Engine.	Horse Power.	Cylinders.		Size of Drums.		Average Hoisting Speed Per Minute, Feet.	Weight Hoisted Single Line Rope, Lbs.	Bed Plate.		Estimated Ship. Weight, Lbs.
		Diam. Inches.	Stroke Inches.	Diam. Inches.	Length Inches.			Width Inches.	Length Inches.	
137b	30	8¼	10	34	30	500	3000	82	85	9500
139d	35	8¼	12	42	38	450	3500	91	90	10800
141f	50	10	12	42	38	600	4500	108	91	11800
142g	50	10	12	48	42	650	4000	108	91	13000
141i	65	11	14	48	42	600	5000	119	97	15500
145j	65	11	14	54	42	650	4500	119	97	16300
146k	75	12¼	15	48	42	550	6500	126	103	19700
147l	75	12¼	15	54	42	600	6000	126	103	21400
150p	100	14	18	60	48	500	8500	143	128	28000
151q	110	14	20	60	60	450	9500	158	132	31000
152r	110	14	20	66	60	500	9000	158	132	33000



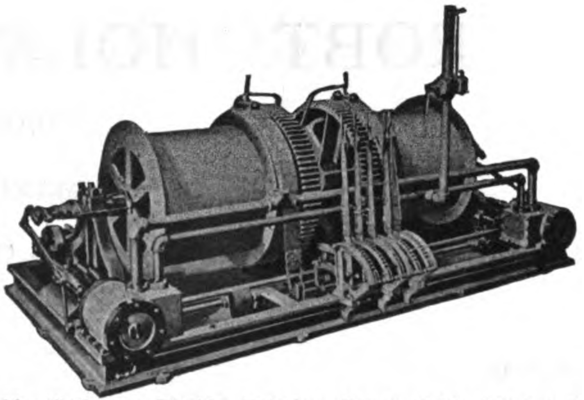
Double Cylinder, Double Band Friction Drum, Link Engine with Powerful Post Brakes and Dial Indicators. Frictions operated by steam thrusts (patented). Special Adaptation: Double Track Inclines, Double Shafts in Mines and Tail Rope Haulage.

For general mining use this engine is especially adapted and recommended for economy and efficiency in operating shafts, etc., as no steam is used for lowering, and, when hoisting, the links may be adjusted with the lever to cut off steam at any point of the stroke, using it expansively in the cylinder.

TABLE OF SIZES, ETC.

Horse Power	Cylinder		Size of Drum		Average Hoisting Speed Per Minute, Feet.	Weight Hoisted Single Line* Rope, Lbs.	Approx. Floor Space.		Estimated Shipping Weight, Complete, Lbs.
	Diam. Inches.	Length Inches.	Diam. Inches.	Length Inches.			Width Inches.	Length Inches.	
45	9	12	37	38	500	4000	92	228	19500
50	10	12	42	38	500	5000	95	234	25000
65	11	14	48	42	550	6000	109	252	38000
75	12¼	15	54	42	600	7000	114	258	46000
100	14	18	60	48	700	8000	128½	280	67000
120	14	20	66	54	700	9000	136	306	78000

* Duty based on 100 pounds steam pressure at cylinders.



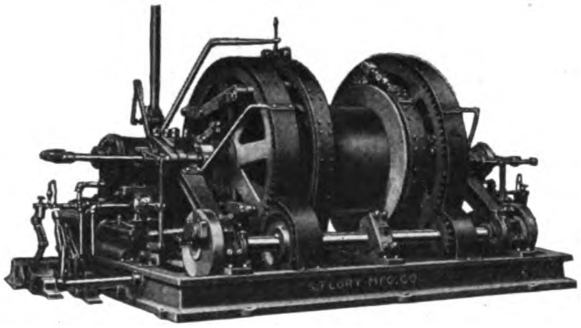
Double Cylinder, Double Friction Drum, Link Engine With Powerful Brakes. Special Adaptation: Double Track Inclines, Double Shafts in Mines and Tail Rope Haulage.

The drums being loose on the shaft, when not in gear, gives them absolute independence of each other in action.

The advantage of this style of engine for Tail Rope Haulage is at once apparent, one drum being thrown into gear winds up the cable while the other, being loose on the shaft, unwinds, and by reversing the engine the opposite winding and unwinding takes place.

TABLE OF SIZES, ETC.

Size Number of Engine.	Horse Power.	Cylinders.		Drum		Average Hoisting Speed Per Minute, Feet.	Weight Hoisted Single Line Rope, Lbs.	Bed Plate		Estimated Ship. Weight, Lbs.
		Diam. Inches.	Stroke Inches.	Diam. Inches.	Length Inches.			Width Inches.	Length Inches.	
239	30	8¼	10	34	30	500	3000	146	85	14200
241	35	8¼	12	42	38	450	3500	162	90	17000
243	50	10	12	42	38	600	4500	167	91	19000
244	50	10	12	48	42	650	4000	172	91	22000
246	65	11	14	48	42	600	5000	194	97	25000
247	65	11	14	54	42	650	4500	194	97	27000
248	75	12¼	15	48	42	550	6500	199	103	30000
249	75	12¼	15	54	42	600	6000	199	103	32000
252	100	14	18	60	48	500	8500	223	125	48000
253	110	14	20	60	60	450	9500	250	132	50500
254	110	14	20	66	60	500	9000	250	132	52500



2 Speed Hoist, with Werner Patented Band Friction, All Cut Steel Gearing, Non-Reversible.

Specially adapted for planes and slopes with variable grades, drag line excavators, car pulls, tipples, switch backs, and general heavy duty hoisting where the load varies and output counts. Frictions are operated by steam thrusts (patented). Regularly furnished with band brake, wood lined, but can furnish any other type brake. Levers can be assembled on hoist, or arranged for remote control.

Note—Duty based on 125 pounds steam pressure at cylinders.

TABLE OF SIZES, ETC.

Horse Power	Cylinders		Size of Drum.		Duty Single Line Rope Pounds.		Speed Feet Per Min.		Approx. Floor Space		Estimated Shipping Weight, Complete, Lbs.
	Diam. Inches.	Length Inches.	Diam. Inches.	Length Inches.	Hoisting	Lowering	Hoisting	Lowering	Width Inches.	Inches. Length	
45	9	12	24	24	3000	6800	600	250	126	92	16000
55	10	12	30	28	3800	8000	650	275	132	95	20000
65	11	14	42	30	4500	9000	700	300	156	109	32000
85	12¼	15	48	36	5300	10000	800	350	168	114	40000
100	14	18	48	42	7000	15000	850	350	186	128½	60000
120	14	20	54	48	7500	16500	850	350	194	136	70000

Use our Patent Vita Bestos brake blocks to eliminate your brake troubles.

ROBT. HOLMES & BROS., Inc.

DANVILLE, ILL.

MANUFACTURERS OF

AUTOMATIC CAR LIFT.

Products

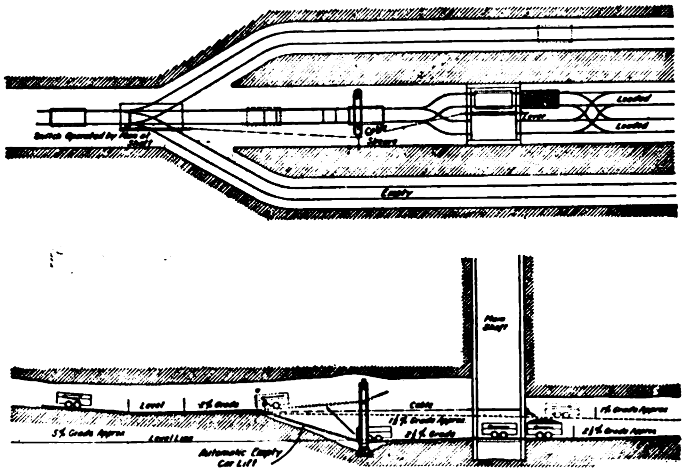
We manufacture Single or Double Automatic Car Lift to handle empty cars in bottom of mines.

Location

The machine is set from twenty to thirty feet from cage landing, opposite load side of shaft. Tracks leading from cage to machine have a fall of three per cent.

Operation

A loaded car is pushed on the cage, bumping off the empty car, which runs down the above mentioned grade until it strikes the forward lever which causes steam or air to be admitted to cylinder by operation of slide valve. Track and car are then elevated to a sufficient height that by gravity the car will be carried far enough back to be reversed and switched to either right or left runaround and thence to main entries, where driver or motorman can hitch on. As the car leaves the movable track it strikes another lever which closes the stream of air ports and opens the exhaust, letting the track down in position for another empty.



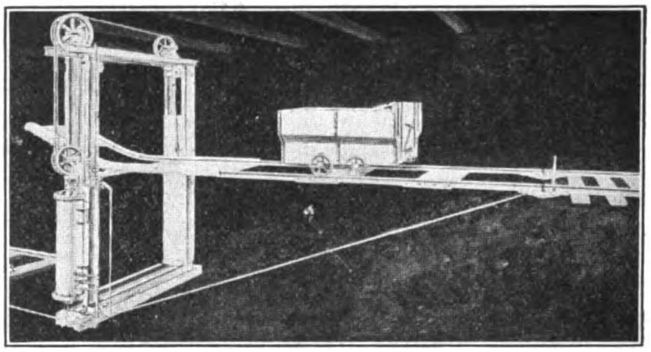
Plan and Cross-Section of Shaft Bottom Arrangements.

The speed of descent of track, and the rapidity of action in lifting cars is controlled by valves which after being adjusted to suit requirements, no further attention to them is required. This machine has a **range of from 4 ft. 6 in. to 12 ft. 6 in. net lift above** top of cage rails. For other elevations see circular describing No. 1 and No. 3 Lifts, both single and double.

Specifications

The above machine is equipped with 15-in. cylinders, requiring a pressure of 80 to 100 lbs. steam or air.

The feed pipe is 1½ in.



Single Automatic Car Lift and Transfer.

The sheaves are all machined, insuring a long life of the cables.

Cables are ⅝ in. crucible steel, with modern fastenings.

All bearings are large, reducing the wear to a minimum.

All levers are made of cast steel and will last a lifetime.

One ½ pint lubricator for each cylinder is furnished.

The track is made of 60 lb. rails riveted firmly together by ¼ in. steel cross plates and equipped with guard rails.

The frame work is made up of 6 in. I beams and riveted throughout with ⅝ in. rivets.

From four to six cars per minute can be handled with this equipment.

Drawing

The drawings necessary for the erection of machine will be furnished free of charge.

THE AUTOMATIC CAR LIFT is exactly what its name implies. The empty car is taken from the cage and lifted to a height which will allow it to travel by gravity back to main entry, thus entirely eliminating congestion of empties at mine bottom.

The consumption of steam or air is directly proportional to the number of cars handled, consequently there is no waste of power in operation, as the steam or air is used only as each car is raised.

The mechanism is not complicated and does not easily get out of order. Each machine is so constructed that the height of lift may be varied within certain limits, thereby assuring perfect action and proper speed of cars.

The only attention required after installing is an occasional oiling. The workmanship and material are of the best, making a strong and durable machine. Will pay for itself every year. Blue prints mailed upon application and further information cheerfully furnished.

ROBT. HOLMES & BROS., Inc.

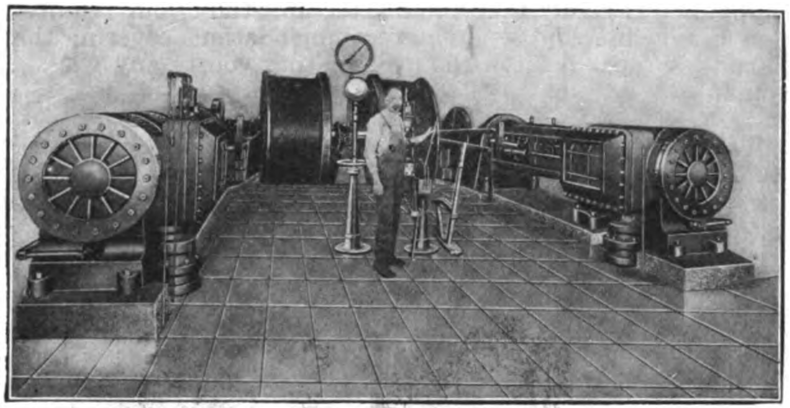
DANVILLE, ILL.

Engineers, Founders and Machinists

"Danville" Hoisting and Haulage Engines

PRODUCTS

Steam and Electric Hoists, heavy duty, first motion with bored guides, steel, cross heads, cranks, links, drums and spiders.



Direct acting or geared from 100 to 1500 H. P.

We use the Beech balanced valve.

All types of Geared, Steam and Electric Haulage and Winding Engines.

Iron and Steel Cylindrical and Conical Hoisting Drums.

Walker's Patent Haulage Drums.

Halbert's Patent Self-Dumping Cages.

Plain Cages, single and double deck.

Holmes' Patent Shaker Screens with single eccentric drive for each section.

Gravity Screens, all types.

Chutes, Straight and spiral

Holmes' Patent End Loading Telescoping Chutes, box type, full or half elbow, adaptable to the loading of highest and lowest cars, without breakage of coal.

Holmes' Patent Weigh Hoppers, with single or double door, steam, air, or hand operated.

Plain and Bicycle Sheaves from one foot to twelve feet in diameter.

Holmes' Car Lift, single and double, will increase your output 25% to 40%. (See opposite page for detailed description.

Iron, Brass and Bronze Castings of all kinds.

Iron and Steel Forgings.

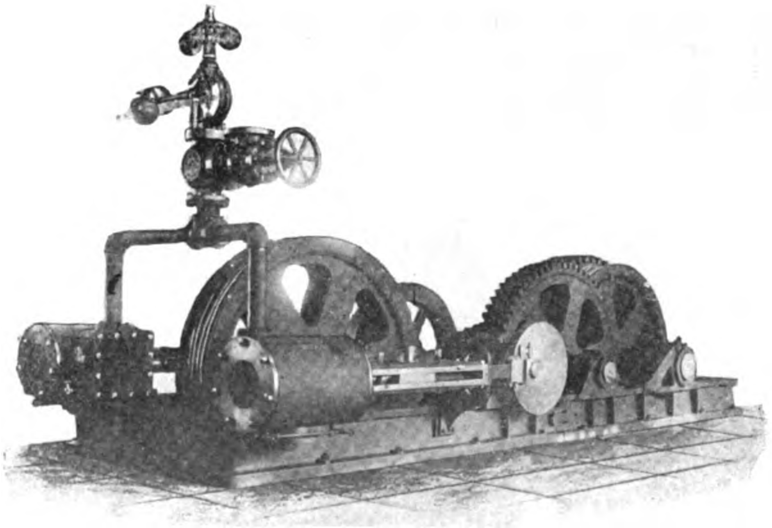
Plate and Sheet Work.

Repairs of all kinds promptly executed.

Cylinders bored and Pistons fitted in position with our portable boring machine. Saves time and trouble and does perfect work.

All kinds of special equipment built to suit your requirements.

Let us figure with you.



Lidgerwood Manufacturing Company

96 Liberty Street, New York, N. Y.

Branch Offices

Pittsburgh **Philadelphia** **Seattle** **Chicago** **Los Angeles**
London, England

Steam and Electric Hoists for Every Mine Service

Products

Steam Mine Hoists up to 1000 H. P.
Electric Mine Hoists in all sizes.

In designing and building mine hoists we bear in mind at all times that the safety of the men, and the continuous operation of the mine, depend upon the hoist. The complete hoist is built with ample strength to fulfill the maximum requirements for which it is desiged, and each individual part is designed and constructed to withstand the strains falling upon it when the hoist is in operation. This attention to both the general design of the hoist, and to the parts entering into its construction, insures not only the safety, capacity and durability of the hoist, but also reduces internal friction in the hoist to the minimum, and makes a smooth running, well balanced machine that will give the maximum rope pull for the power consumed.

All castings are made in our own foundry. This enables us to give the most rigid supervision to the manufacture of every part of the hoist, and to the selection of the material entering into same.

We have been building steam hoists since 1873 and electric hoists since 1890. The Lidgerwood Mine Hoist of today embodies every improvement suggested by this experience. We are not in the position of the manufacturer who makes one type of hoist only, and must therefore be emphatic in recommending that type. Our method is to analyze your hoist conditions and then recommend the type of hoist suited to your particular requirements.

Advise us what are the conditions at your mine, and the hoisting duty you wish to perform. We will gladly take the matter up, study your requirements, and send you recommendations covering the proper hoist without obligating you in any way.

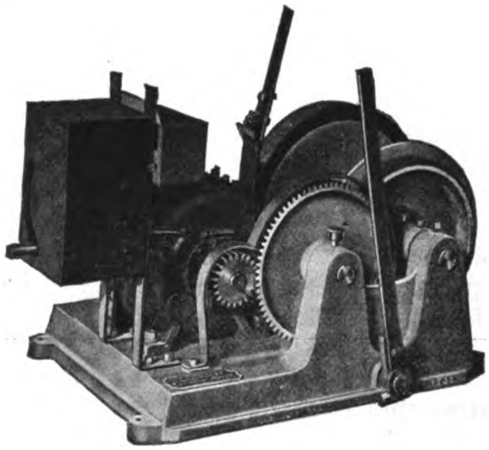


Fig. No. 1235.

Small Mine Hoist built with Direct Current or Alternating Current Motor, coiling 1,000 ft. of 3/8″ rope, or 800 ft. of 1/2″ rope, adapted for handling cars in headings, rooms, on tipples, and various other uses around mines. Rope pull 800 to 1500 lbs., speed 75 to 125 F. P. M.

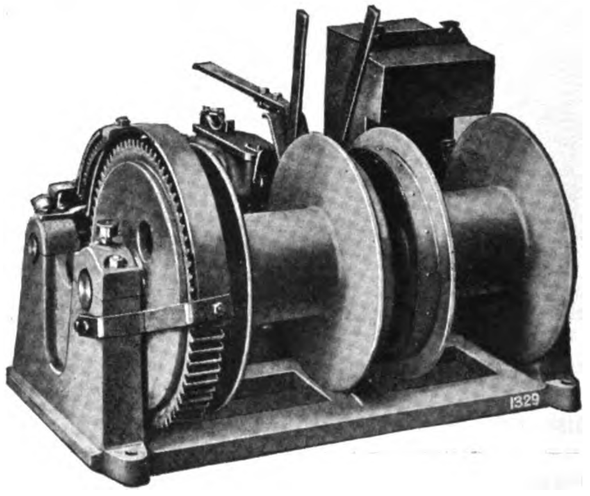


Fig. No. 1329.

Small Double Drum Mine Hoist, with Direct Current or Alternating Current Motor. Each Drum coils 1,000 ft. of 3/8″ rope, or 800 ft. of 1/2″ rope. Operates small tail rope systems; used around tipples; hauls cars from cross cuts to main heading, operating two cross cuts; drums work independently of each other. Same duty as Fig. 1235, one drum at a time.

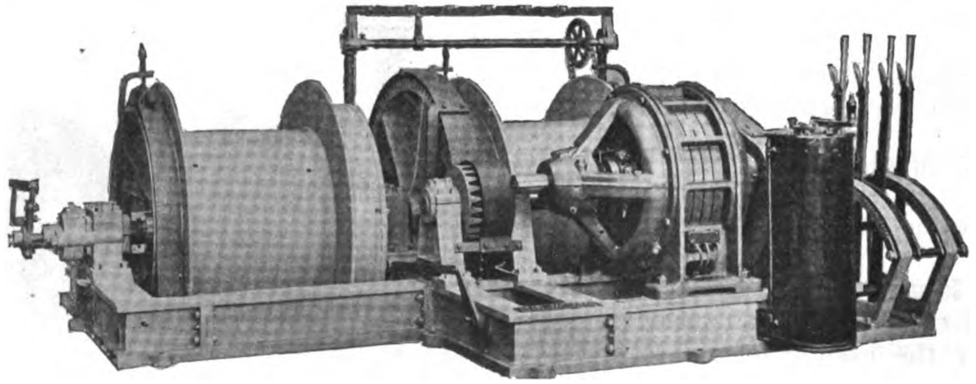


Fig. No. 981.

Double Drum Hoist for operating tail rope systems. This type made in capacities of 3,000 lbs. to 20,000 lbs. rope pull at the drum, and rope speeds from 200 to 600 feet per minute.

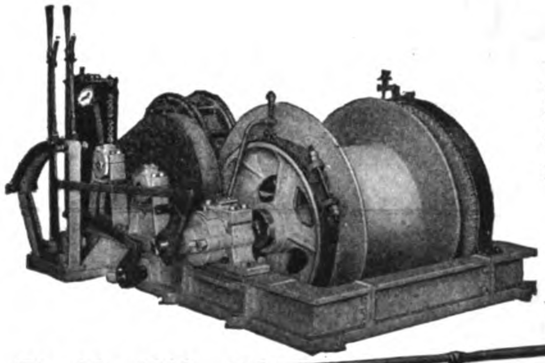


Fig. No. 1247

One type of single drum heavy duty haulage hoist, for use particularly where short rope leads are required, and where the cars will run one way by gravity. Built with either direct or alternating current motors.

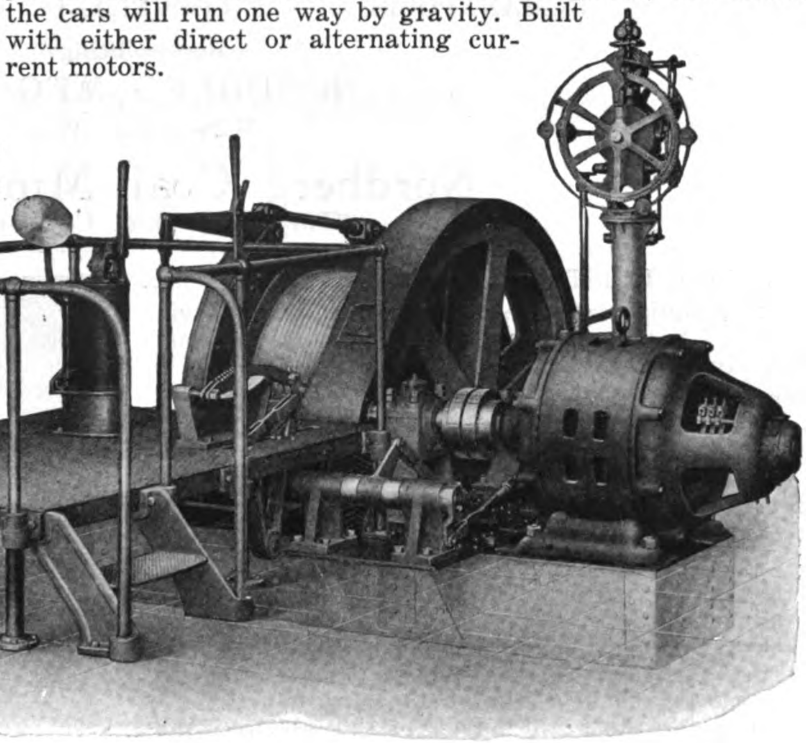


Fig. No. 1290.

Vertical Shaft Hoist.

Single Fixed Drum Shaft Hoist for handling two cages in balance, or one cage and counterbalance. Mechanical safety device absolutely preventing overwinding and overspeeding. Operated either from platform at hoist, or by remote control from headframe. Built in any required size.

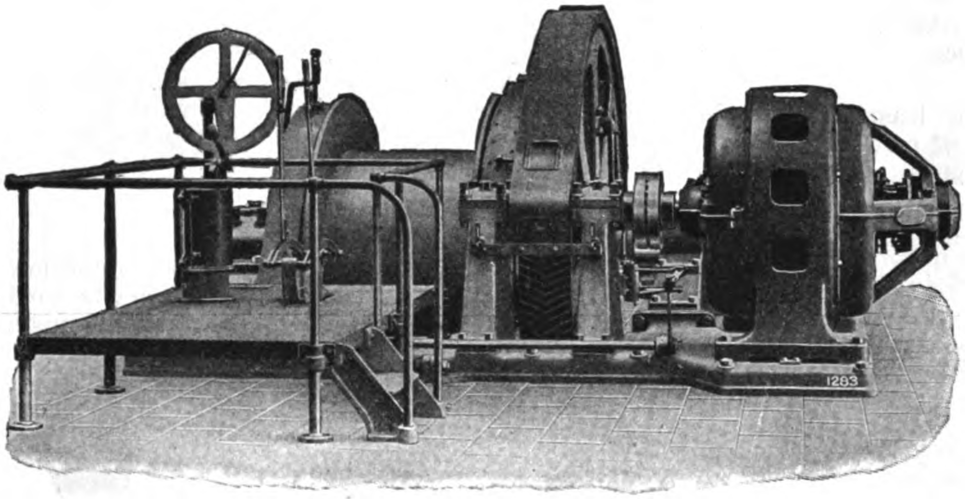


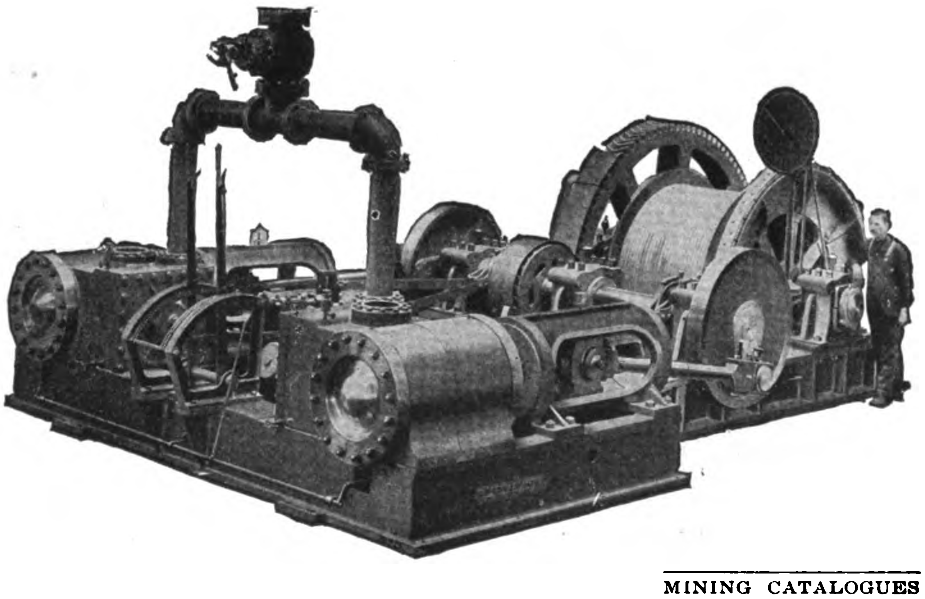
Fig. 1283.

Band Friction Haulage Hoist. Hoist illustrated is hauling trips of 40 cars a distance of 6,000 feet, making an average of four trips per hour. Built in any required size.

Fig. 827

Single fixed drum, haulage engine. Double cylinders 24″ diameter, 30″ stroke, drum 72″ diameter, 48″ face.

Steam hoists in sizes up to 1,000 HP, built for all types of mine work.



DRAVO-DOYLE COMPANY

PITTSBURGH
INDIANAPOLIS CLEVELAND PHILADELPHIA
Representing
NORDBERG MFG. CO
Milwaukee, Wis.

Nordberg Coal Mine Hoists

"The Standard of Comparison"

ELECTRIC HOISTS

This equipment especially designed for electric service. Not an adaption of steam hoist designs. Any capacity above 100 horsepower.

Shaft Hoists

For tight or slack rope operation. Installations in Pittsburgh District of 700 HP. each and smaller. Installations in metal mines up to 1800 HP., the largest electric hoist in America. (See cut opposite).

Slope and Haulage Machines

Single or double drums. The highest development in clutched drum hoists.

Engineering Service

Our Engineering Department is always at your service for consultation without obligation. Experience gained in designing the largest and fastest hoists in the world is back of this service. We can always give you, promptly, approximate prices, delivery and power requirements for your conditions. Consult our nearest office.

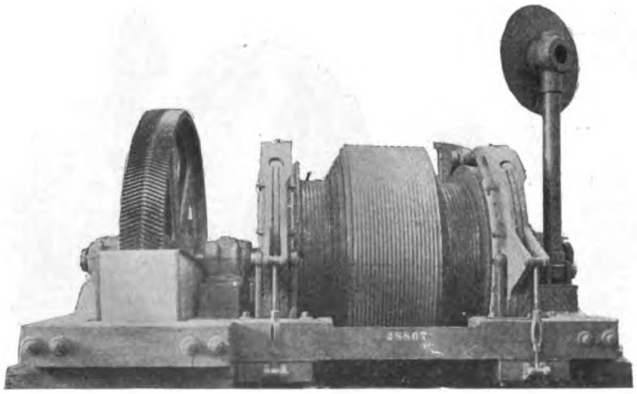
Special Features

Drum Design to use the least power and demand the smallest safe size of motor.

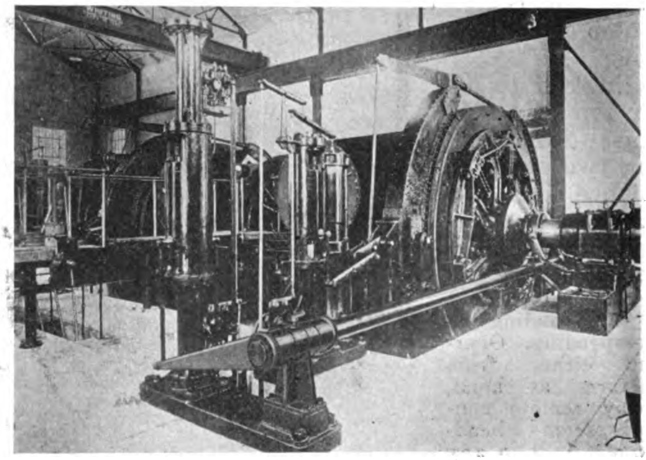
Brakes of design developed in most exacting metal mine work. Brakes all of post type with true parallel motion. All parts of brakes in duplicate. Failure of no single part disables brake. Oil operation of brakes developed to a point far in advance of any other method of operation.

Safety Devices. Every safety feature known to the hoisting engineer is provided. Further features exclusively of Nordberg design make our apparatus doubly safe.

Design Standards. There is only one kind of Nordberg hoist. It is the best we know how to build in every feature of design and workmanship. We use only herringbone gears, parallel motion post brakes and axial plate clutches.



Cylindro-Conical Drum Shaft Hoist with upper half gear case removed. Rear view.

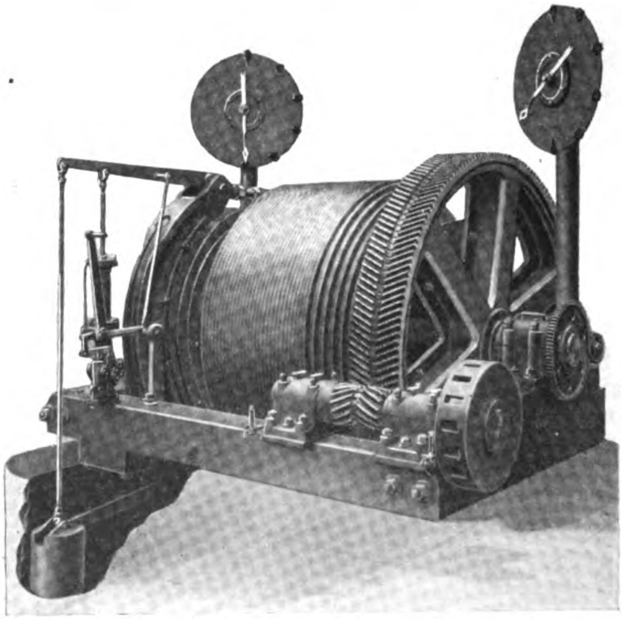


Nordberg Electric Shaft Hoist—1800 H. P.

Service. Our own trained corps of mechanics and erecting superintendents are located in Pittsburgh. Quick competent personal service is assured our customers. We are equipped to make complete hoisting installations turning hoists over to customer in operation.

STEAM HOISTS

For heavy loads, long lifts, high speeds and low steam consumption, Nordberg steam hoists hold world's records. We will be glad to quote upon suitable equipment for shaft or slope.



Small Cylindro-Conical Hoist. Oil operated brakes.

Dravo-Doyle Company Stand Permanently Behind Their Installations.

Litchfield Foundry & Machine Co.

Litchfield, Illinois.

Designers and Builders of

Hoisting and Haulage Machinery

Steam or Electric.

"Litchfield" Hoists

Are built in all sizes for every kind and variety of service.

Boiler Steel Shell Drum Faces with Annealed Cast Steel Spiders, Steel Cranks, and Steel Crossheads. All have a very high factor of safety.

Heavy Steam Reverse Auxiliary Engines, with Heavy Links and Reversing Mechanism.

Heavy Steam Brake Auxiliary Engines, with Improved Heavy Brake, and Equipment.

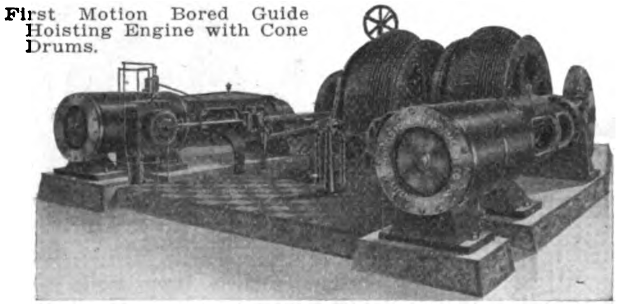
Safety Stops and Overwind Devices.

Walker Patent Differential, W. I. Spoke, Haulage Drums. Depression Sheaves, and Rollers.

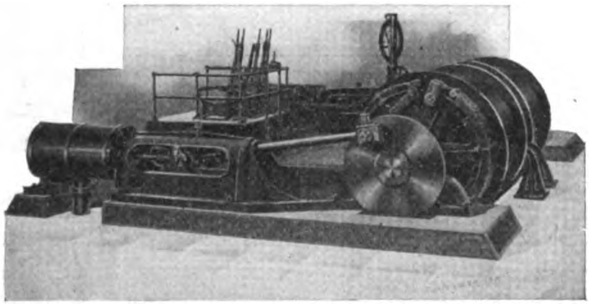
Morgan Patent Cable Grips, Standard or Extra Heavy Type, and All Haulage Equipment.

Our Special Machines Pass U. S. Government Inspection.

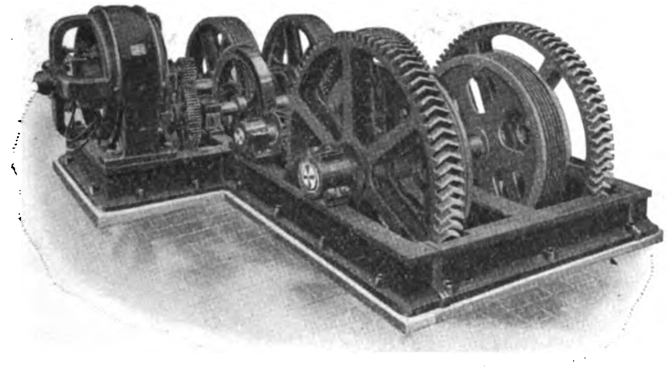
Special Machinery built to order.



First Motion Bored Guide Hoisting Engine with Cone Drums.



First Motion Tail Rope Haulage Engine With Band Friction Clutches.



Electric Driven, 4 Drum Compound Geared, Endless Rope, Haulage Machine.

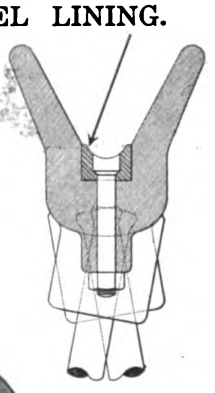
"Litchfield" Bicycle Type Sheaves

(Give Maximum Service). Our method of manufacture eliminates all shrinkage strains.

Made in sizes from 24 inches to 12 feet in diameter.

We offer you the best in design, material and workmanship.

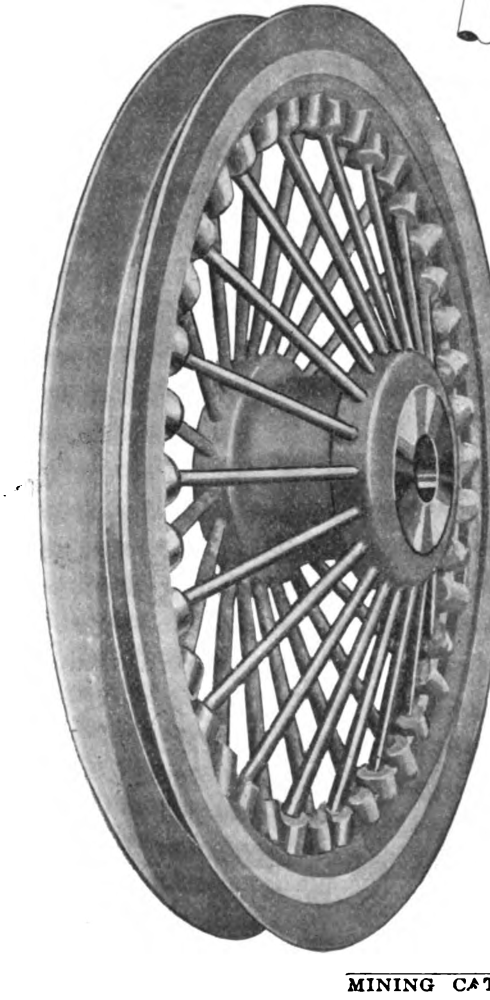
OUR IMPROVED HEAVY DUTY SHEAVES HAVE RENEWABLE STEEL LINING.



Repeat Orders, From the Largest Modernly Equipped Mines, Indicate the Merit of These Sheaves.

Prompt estimates for your requirements.

The Best Is "Safety First."
Quality and Service.



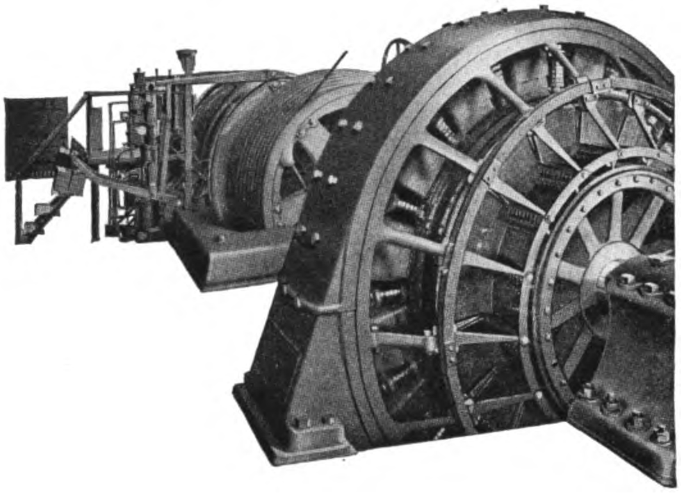
OTTUMWA IRON WORKS

Ottumwa, Ia., U. S. A.

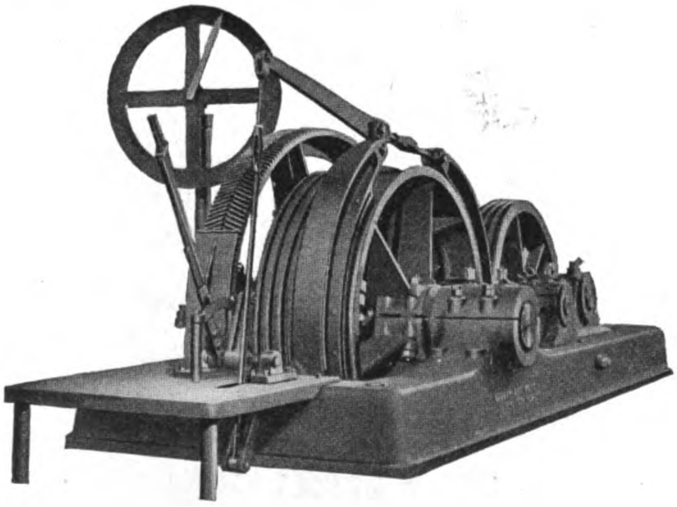
Designers and Manufacturers of

Electric, Steam, and Air Hoists

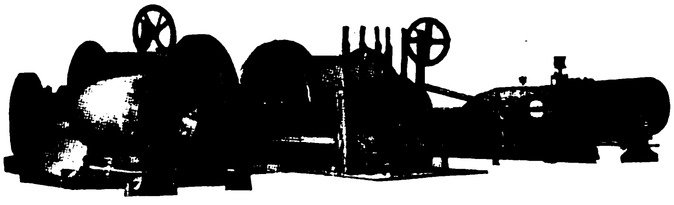
Ottumwa hoists cover a wide range of types and designs and they solve all hoisting problems. "Ottumwa" insures safety, service and higher economy of operation. They are handling the large jobs as well as small. Every Ottumwa hoist is backed by over 40 years of experience in designing and building hoisting machinery. Write for our new catalogue No. 30, which tells more about our line of machinery.



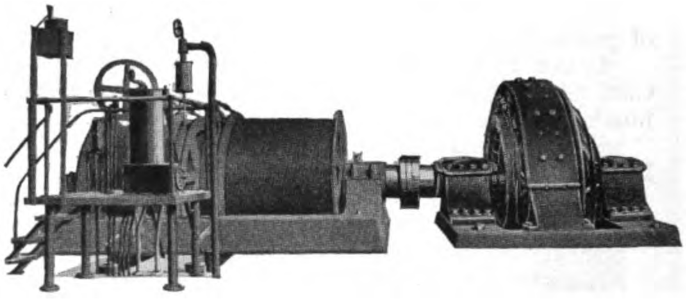
1300 H. P. Electric Hoist.
Largest coal mine hoist in the world. Rope pull 38000 lbs.; rope speed 2000 ft. per minute.



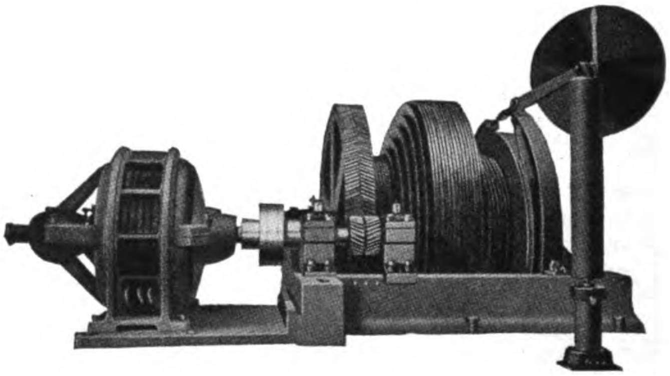
200 H. P. Endless Rope Haulage Machine, Electrically Driven.



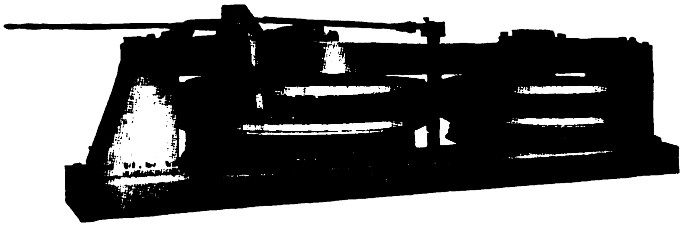
1200 H. P. Steam Hoist.



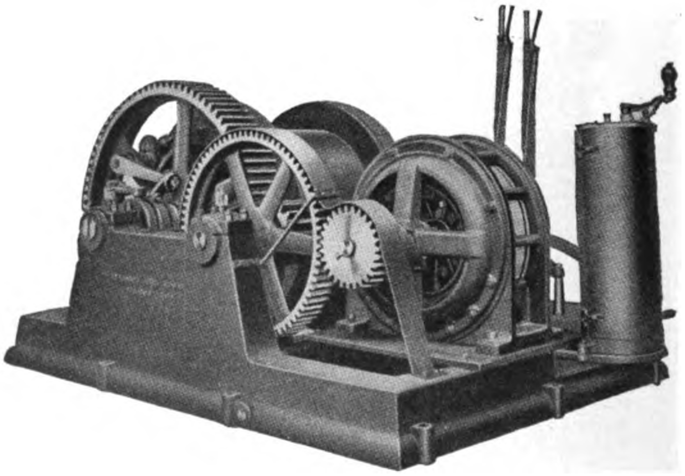
1150 H. P. Electric Hoist.
Rope pull 21800 lbs. Rope speed 2400 ft. per minute.



225 H. P. Cylindro-Conical Drum Hoist.



Gravity Plane Machine for Inclines.



Small Electric Hoists 5 to 75 H. P.

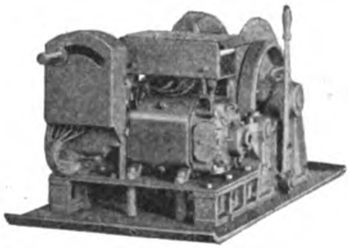
WRITE FOR CATALOG NO. 30.

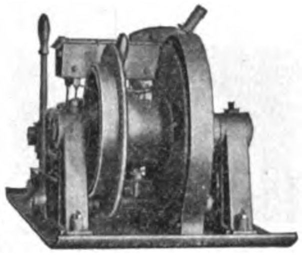
The Pneumelectric Machine Company

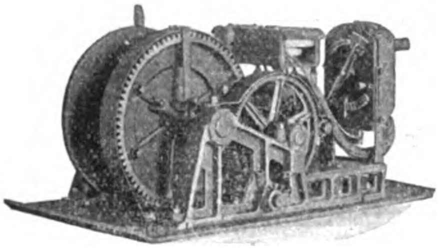
SYRACUSE, N. Y.

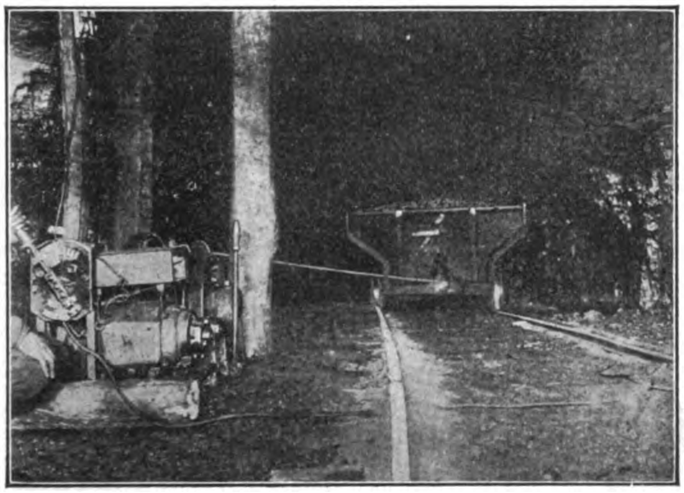
Pneumelectric
TRADE MARK

Electric Room Hoist









A small portable electric Hoist that is built especially for hauling mine cars and hoisting light loads in and about coal mines. It is furnished standard with one or two drums, as conditions may require.

Uses

Single Drum Hoist—Hauling mine cars on local grades in headings or rooms. Hoisting material anywhere around a mine. Hauling cars to or from dumps or tipples and on slopes.

Double Drum Hoist—Hauling cars by head and tail rope system for short distances. To do the work of two single drum hoists in special cases.

A very important application of the Single Drum Hoist is for the handling of cars from the working faces in headings. It eliminates delays for the men and for the locomotive and helps to speed up heading advancement. The hoist is always on hand when the miner has the car loaded ready to move and delays are avoided, while at the same time the miner is relieved of the very hard work of pushing the car.

Specifications

Rope Rrum—Capacity 900 ft. of ⅜″ or 500 ft. of ½″ rope.

Motor—Rated hoist capacity, 5 H. P. Can be furnished for any standard voltage, either D. C. or A. C. The motors are specially built for this purpose and possess features that make them unusually well adapted to the particular demands of mine service.

Gearing, etc.—All spur gearing, double reduction cut gears; heavy shafts and bronze bushed bearings; positive clutch; automobile type band brake.

	Width	Length	Height	Weight
Single Drum Hoist	28″	52″	26″	830 lbs.
Double Drum Hoist	44″	52″	26″	1375 lbs.
Tripple Drum Hoist	60″	52″	26″	1920 lbs.

Performance

The Pneumelectric Room Hoist will give a rope pull up to 1800 pounds at a speed of from 200 feet per minute at no load to 100 feet per minute on full load.

South Side Foundry & Machine Works

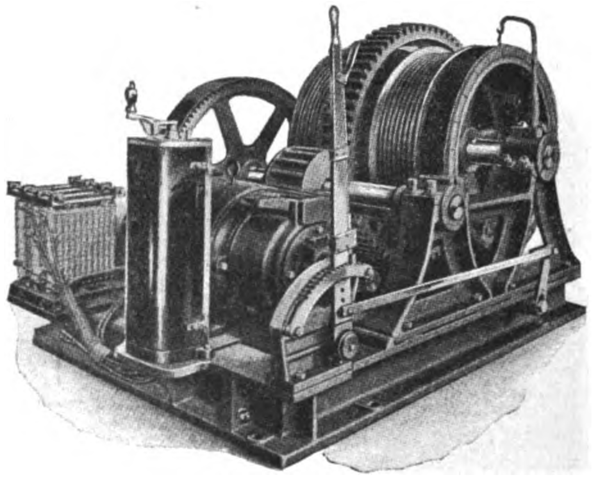
CHARLESTON, WEST VIRGINIA

Designers and Builders of

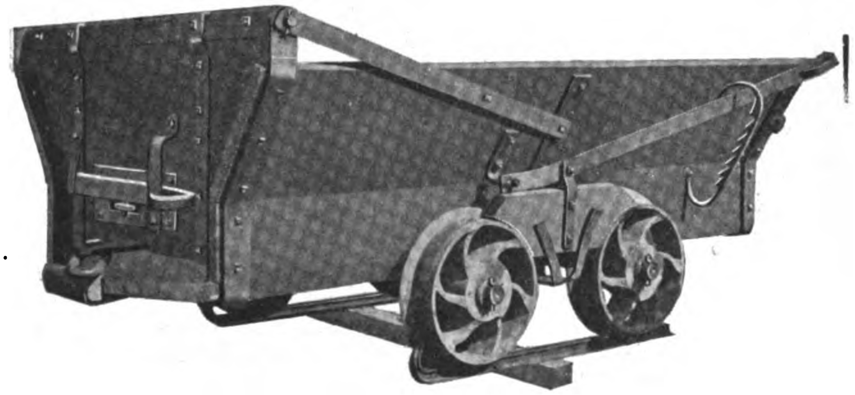
Complete Mining Equipment, Steam and Electric Hoists and Haulages for Coal Mines

Products.

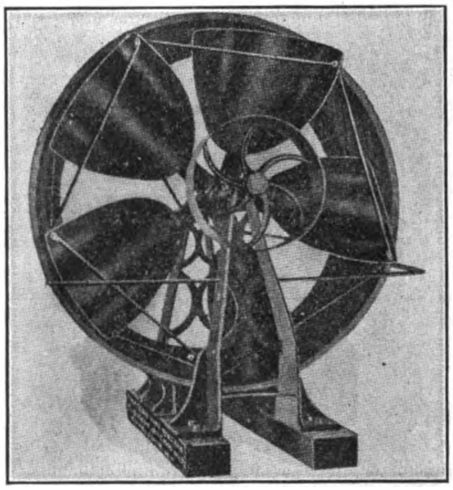
Incline Drums and Monitors; Sheave Wheels; End and Cross-over Tipple Dumps; Improved Shaker Screen Outfits; Boom Loaders and Picking Tables; Mine Ventilating Fans, steam and electric driven, from 3 feet to 10 feet in diameter; Portable Hydraulic Wheel Presses; Cages, plain and self-dumping, for Shaft Mines; Patent Ratchet Rail Benders; Miners' Ratchets and Drills. Large stock Wire Rope, Boiler Tubes, Pipe and Fittings, Vertical Boilers and Hoisting Engines. Iron and Brass Castings. Mine Cars, any style or type.



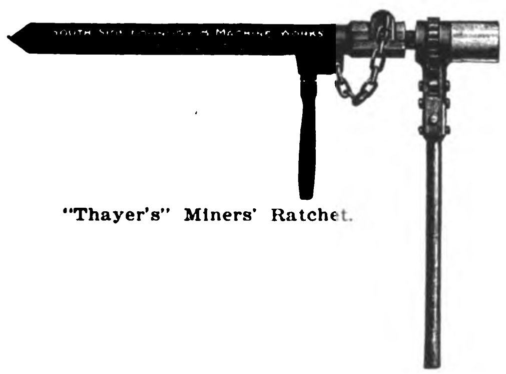
Electric Hoistong Machine for Hoisting Cages in Shaft Mine.



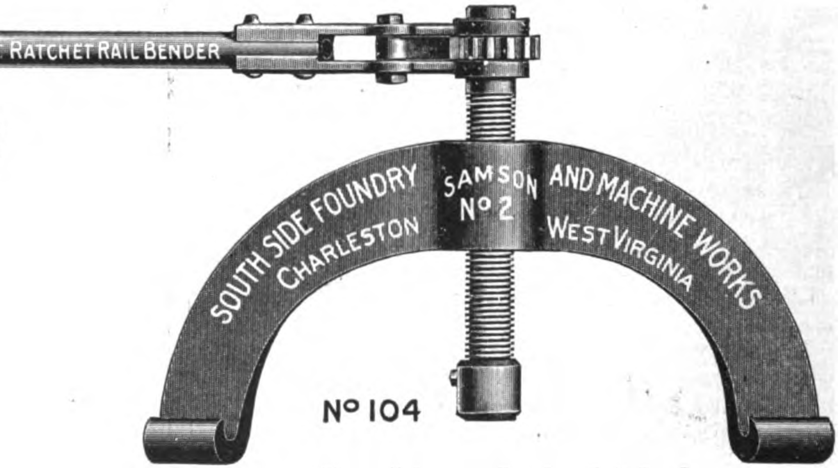
Standard Mine Car, Built to Specifications.



Cut of Belt Driven Mine Ventilating Fan. Made in sizes 3 ft. to 10 ft. Also furnished with direct, connected engine, self-contained.


SOUTH SIDE FOUNDRY & MACHINE WORKS

"Thayer's" Miners' Ratchet.



"Thayer" Samson Ratchet Rail Bender. Capacity up to 45-Pound Rail

VULCAN IRON WORKS

WILKES-BARRE, PA
NEW YORK CHICAGO

Vulcan Steam and Electric Hoists; Steam, Gasoline and Air Locomotives, Mine Ventilating Fans

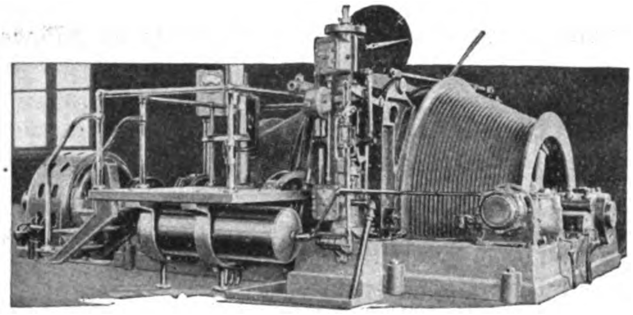
Products

Vulcan Electric Hoists and Haulage Machines for Construction Work and Mining; Vulcan First Motion Steam Hoisting and Haulage Engines; Breaker Driving Engines; Geared Engines; Corliss Engines; Stationary Steam Engines with slide, piston or Corliss valves, simple or compound.

Vulcan Steam Locomotives up to 199 tons weight, with saddle tank or separate tender; Vulcan Gasoline Locomotives; Vulcan Compressed Air Locomotives.

Vulcan Mine Fans and other ventilating equipment; Safety Cages and other Mining Machinery.

Vulcan Locomotive-Type and Return-Tubular Boilers. Vulcan Steel Stacks. General Iron Work. Nicholson Overwind and Automatic Control Devices.



Hoist Made for New River Co.

Vulcan Engineering Co-operation In All Departments

In the conviction that the best results in the construction of hoists or of any other machinery are obtained when the buyer and the manufacturer co-operate, the Vulcan engineering staffs are always at the service of our prospective buyers, to assist in analyzing and solving their problems.

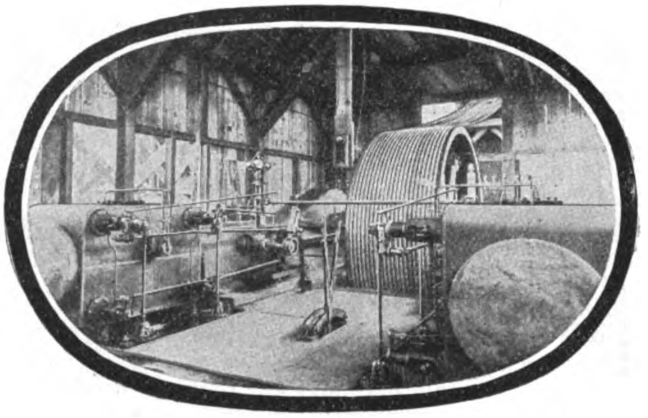
The Vulcan Iron Works are divided into distinct departments, each with its own staff of engineers, so that all work may be done by specialists.

The prospective buyer entails no obligation on himself when he avails himself of the services of Vulcan engineers.

The Vulcan Plants

Their equipment and capacity are sufficient to take care of practically any special work or any volume of business which may come to them. To these advantages may be added excellent shipping facilities to insure more prompt deliveries to purchasers.

For sixty-eight years, since the founding of the Vulcan Iron Works, Vulcan Hoists and Breaker Driving Engines have been constantly improved. A continuous study of coal mining conditions everywhere have resulted in the building up, course by course of an organization whose relations with its clients have resulted in a constantly increasing business—the best proof of a worthy and dependable output.



Breaker Driving Engine Made for St. Clair Coal Co.

These years of experience and study have produced a number of stock hoist designs to cover the usual requirements with quick deliveries. For those cases where special conditions exist the Vulcan Engineering Department is ready to co-operate with the prospective buyer in thoroly analyzing the governing factors.

SPECIAL FEATURES

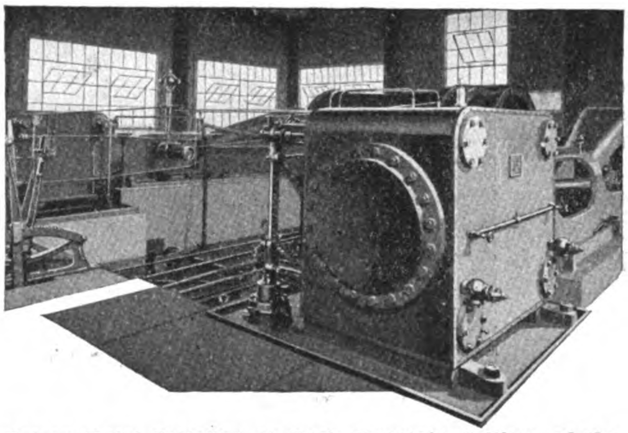
Frames and Pedestals—Heavy. cast-iron box-section. The distribution of metal in the beds is the result of careful calculation—putting the most metal where it is needed.

Gears—The metal depends on the particular conditions the hoist is to meet. The teeth are always cut from the blank. Spur gears are generally used in the smaller hoists, while WUEST herringbone cut from a solid blank, are preferable in larger machines. All gears are enclosed.

Bearings—They are very generously proportioned. The diameter and length of VULCAN Hoist Bearings give them greater area per unit load than usual practice.

Drums—Are ordinarily made of smooth or grooved cast iron, mounted on cast iron spiders. For extra heavy service cast steel is the proper metal.

Brakes—Steam, electric or air, according to the hoist, with either contracting band or post-shoe application.

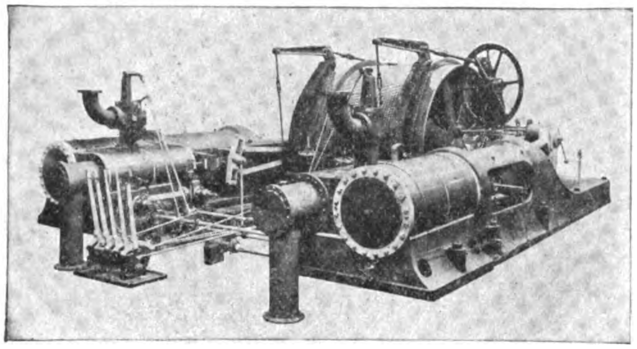


Vulcan Hoist Installed at Buck Mountain Colliery of the Lehigh Valley Coal Co.

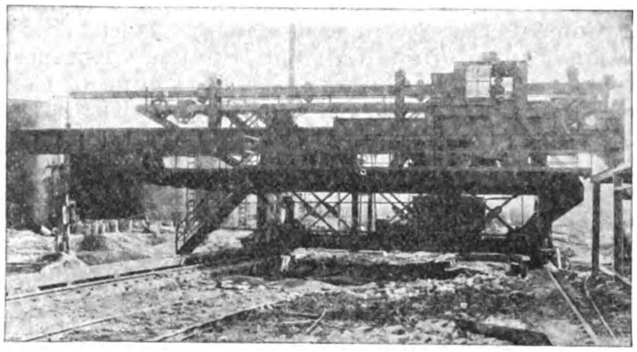
The Wellman-Seaver-Morgan Company

Cleveland, Ohio, U. S. A.
New York Office: 50 Church St.
Denver Office: 612 Ideal Bldg.

Steam and Electric Hoists and Hauling Engines



First Motion Hoist.
Maryland Coal Co. of Penna.



Coke Pusher for By-Product Ovens.

W-S-M hoists are built in all sizes for every kind and variety of service. The complete equipment of our two large factories, including steel foundry, forge and extensive machine shops, enables us to handle work of the heaviest character.

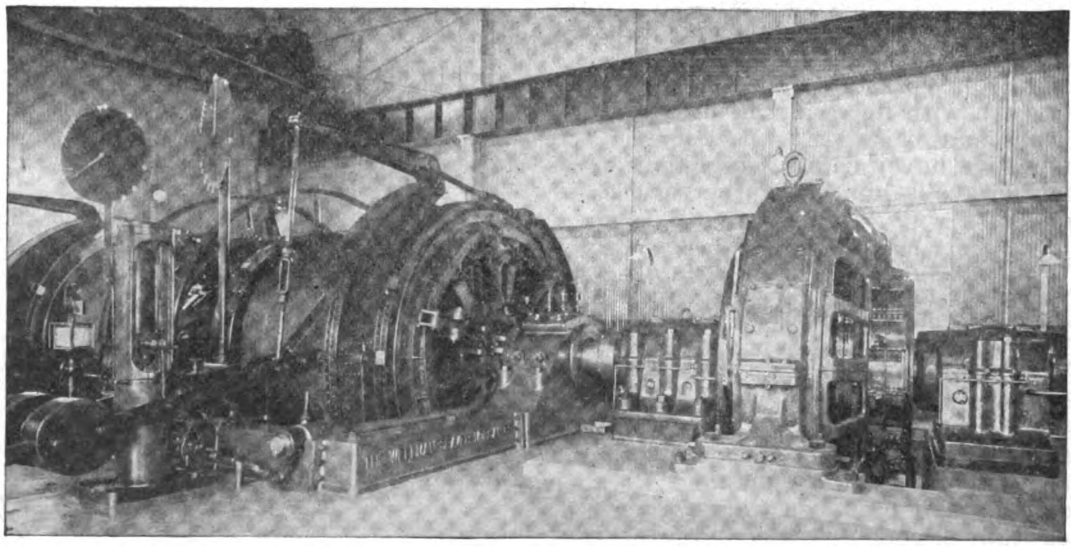
Strength and efficiency are the first considerations in designing W-S-M steam or lectric hoists.

A long list of satisfied customers is our best advertisement, to whom we gladly refer prospective customers.

Our electric hoists are equipped with machined herringbone gears encased in oil tight housings, steel drums, weighted steel safety brakes and powerful steel clutches; also the completest possible safety equipment to prevent over-speed or over-winding.

Send for catalogues of our specialties as follows:

Steam and Electric Mine Hoists.
Endless Rope Haulage Plants.
Mine Cages, Skips and Ore Cars.
Rotary Car Tipples.
Hulett Coal-Handling Bridges and Buckets.
Coal Pier Machinery.
Car Dumpers for Coal Shipment.
Coke Pushers, Coal Leveling, Quenching and Loading Machines for Coke Ovens.
Hughes Gas Producers.
Hydraulic Turbines.



The Largest Electric Hoist in America. North Butte Mine, Butte, Montana.

THE FALK COMPANY

Milwaukee, Wisconsin

Manufacturers of

Wuest Herringbone Gears For All Classes Of Mine Equipment.

AGENTS AND BRANCH OFFICES:

Pittsburgh, W. O. Beyer, 1024 Park Bldg., Pittsburgh, Pa.
New York and New England, M. P. Fillingham, 50 Church St., New York City.
West Coast, F. W. Grimwood, Rialto Building, San Francisco, Cal.
Pennsylvania Coal Fields, Vulcan Iron Works, Wilkes Barre, Pa.
Colorado District, Denver Engineering Works Co., Denver, Colo.

The use of Wuest Gears in connection with mine hoists, pumps, tube mills and other mining plant has led to a great simplification in design combined with reduced power consumption and complete absence of shock and vibration with elimination of noise.

These remarkable gears are hobbed from solid blanks on special machines designed and built for this purpose.

Practically all gear problems in connection with mining plant can be met with a single gear and pinion where double and triple trains were formerly used.

Wuest Gears with a reduction ratio of 20 to 1 are not uncommon.

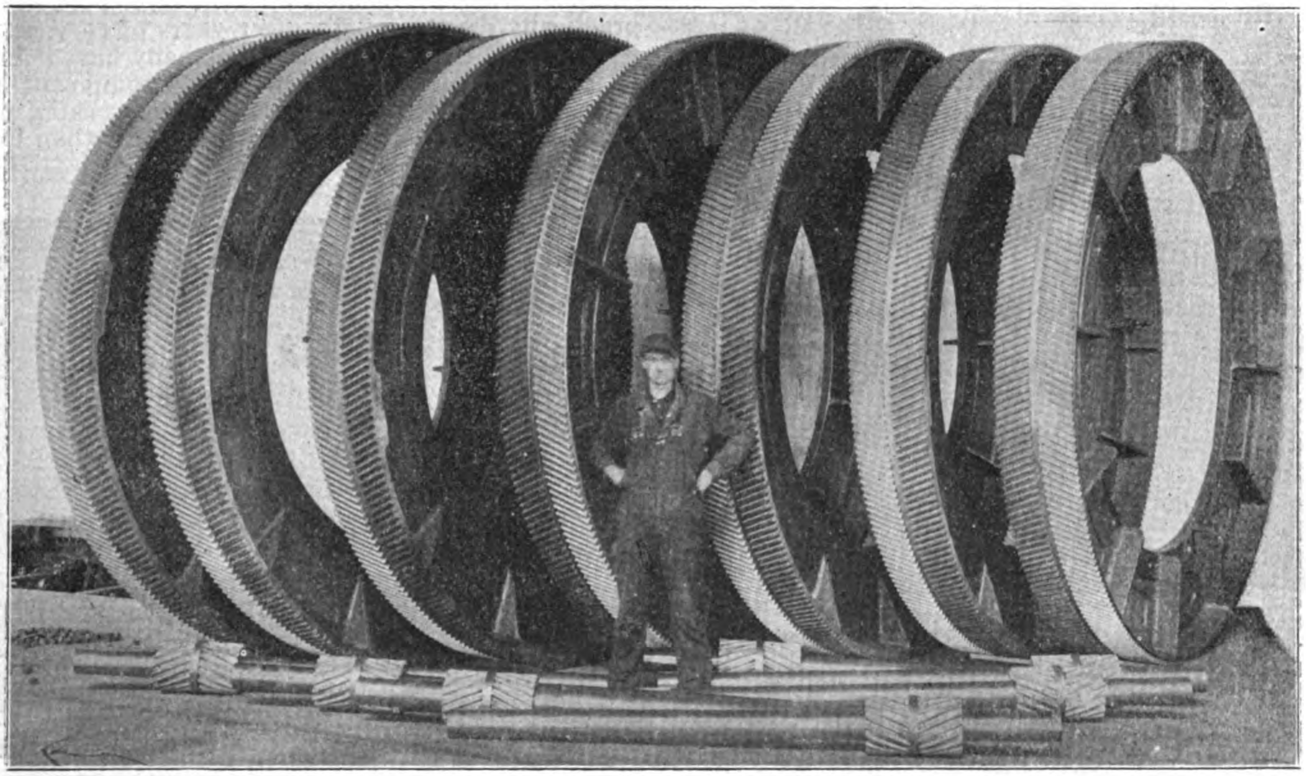
For the electrification of mine hoists and pumps these gears are indispensable.

The illustration shows a group of high ratio Wuest gears for 300 H. P. ball mills. The cast steel gears are made in ring form for mounting direct on the mills. The pinions are forged solid with their shafts and the shafts are coupled to the motors.

The smooth running qualities of Wuest gears have led to their adoption on steam and air driven hoists where high ratios of reduction are not needed.

We manufacture special fly wheel gears for large air compressors driven from high speed motors.

Full particulars for any kind of drive may be obtained by application to The Falk Company.



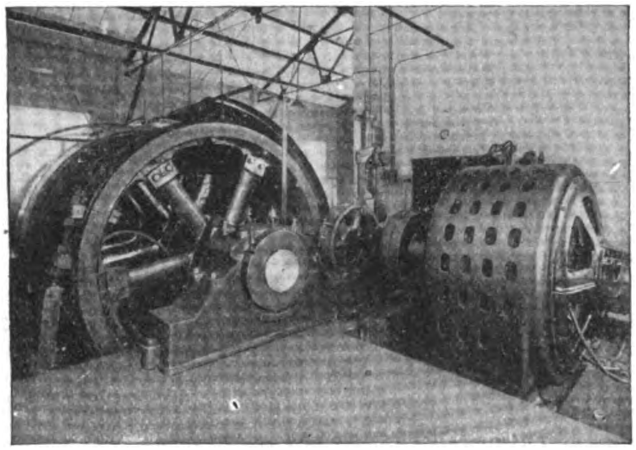
GENERAL ELECTRIC COMPANY

General Office:
Schenectady, N. Y

The Guarantee on Goods of Excellence Electrical

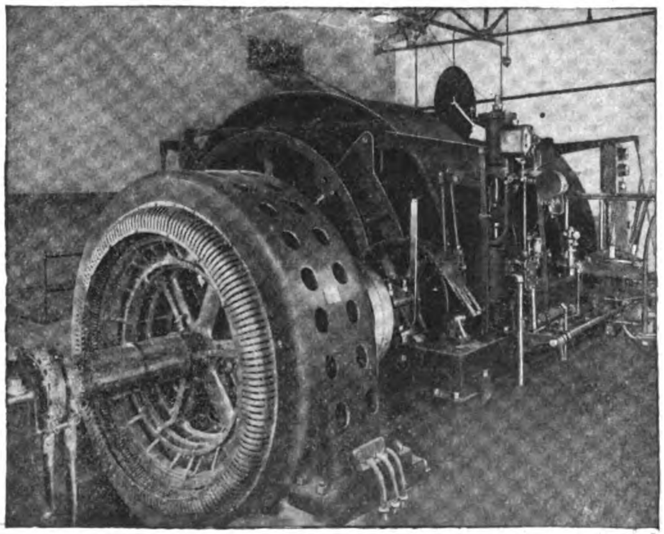
Sales Offices
In All Large Cities

Electrical Equipment for Mines---Hoists



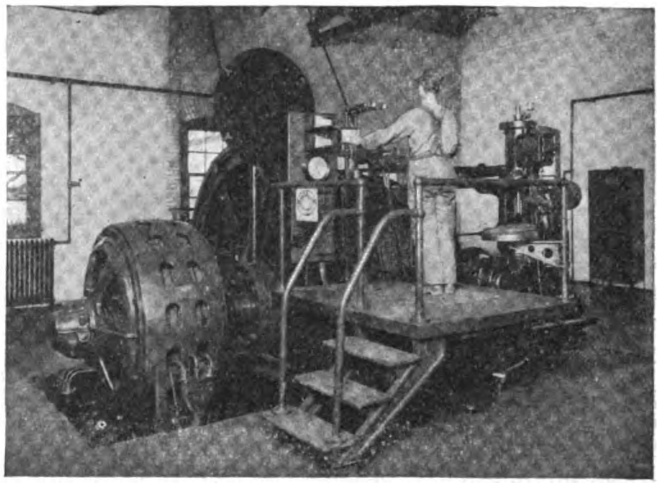
750 H. P. Hoist, No. 5 Shaft, Lehigh Coal & Navigation Co.

Mine hoists driven by G-E motors are operated at low costs because, first, boilers are eliminated, saving cost of their attendance; second, vibration on rope is decreased—increasing its life and that of the head gear, etc., finally because no power is used during idle moments though ample power is always available when needed.



1200 H. P. G-E Motor Driven Water Hoist.
Lehigh Coal and Navigaton Co.

In 1912 South African engineers selected G-E equipment for the largest hoist in the world. This 4000 h. p. hoist has carried momentary loads of 11,000 h. p. on test.

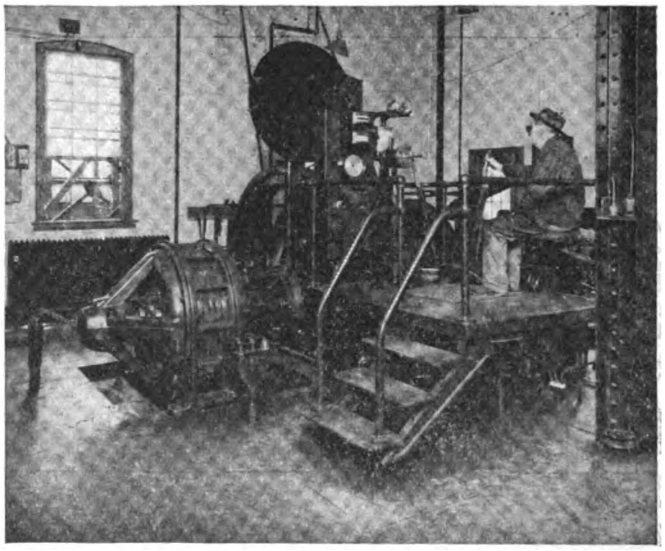


75 H. P. Auxiliary Hoist, Pittsburgh Coal Co., Montour No. 2.

The Tennessee Coal & Iron Company ordered the motor and control equipment for the largest 1800 h. p.—alternating current hoist in the world from the General Electric Company.

Scores of smaller hoists are driven by G-E equipment and in common with the large ones have practically no repair bills after years of service.

A large Pennsylvania Coal Company have a 750 h. p. electric hoist, operated by G-E equipment at Lansford, Pa., which they state when working up to capacity, has an electric power bill less than the boiler labor required with steam hoists.



300 H. P. Hoist, Pittsburgh Coal Co., Montour No. 2.

GENERAL ELECTRIC COMPANY

General Offices:
Schenectady, N. Y.

The Guarntee on Goods of Excellence Electrical

Sales Offices
In All Large Cities

Electrical Equipment for Mines--- Hoists

G-E motor driven hoists have been installed in large numbers during the past year 1916-17. Many of these hoists were furnished on repeat orders from satisfied users.

APPROXIMATE LIST OF ELECTRIC COAL MINE HOIST INDUCTION MOTORS 250 H.P. AND ABOVE

Name of Company and Location of Mines	Inclination to Horizontal	Maximum Depth in Feet	Material Per Trip in Lb.	Wt. of Skip or Cars and Cage	Rope Speed in Ft. Per Min.	Hoist Motor Rating in H.P.	Hoist Motor Speed in R.P.M.	Hoist Motor Voltage	Hoist Motor Frequency
Lehigh & Wilkesbarre Coal Co., Ashley, Pa.						250	450	440	60
Lehigh & Wilkesbarre Coal Co., Wilkesbarre, Pa.						250	450	440	60
Certo de Pasco Mining Co., Peru, S. A.	90°	1000	7,000	7,500	800	250	450	2200	60
Consolidation Coal Co., Acosta, Pa.	90°	440	3,500	10,000	1225	250	450	2300	60
Langeloth Coal Co., Burgettstown, Pa.	90°	150	4,000	11,000	990	250	450	440	60
Rum Creek Collieries & By-Products Co., Dehue, W. Va.	90°	140	4,000	13,200	880	250	450	2200	60
Consolidated Coal Co., Gray, Pa.	90°	345	2,770	11,150	1335	250	450	2300	60
Davis Coal & Coke Co., Cumberland, Md.	2¾°-3½°	7000	52,500	27,000	750	270	600	550	60
Philadelphia & Reading Coal & Iron Co., Shamokin, Pa.	20°	500	23,700	10,800	600	275	450	2100	60
Pittsburgh Coal Co., Pittsburgh, Pa. (3 equipments)	90°	220	8,000	12,000	800	300	300	2300	60
Pennsylvania Coal Co., Dunmore, Pa.	3½°-9°	2775	71,000	33,000	500	300	450	440	60
Pennsylvania Coal Co., Dunmore, Pa.	2½°-9°	3535	71,000	33,000	500	300	450	440	60
Pennsylvania Coal Co., Dunmore, Pa.	5°-11°	4930	71,000	33,000	500	300	450	440	60
Consolidated Indiana Coal Co., Melcher, Iowa	90°	215	4,000	8,700	1030	300	450	2200	60
Consolidation Coal Co., Jenner, Pa.						300	450	2200	60
Greensburg Coal & Coke Co., Greensburg, Pa.	90°	190	4,500	13,650	1140	300	450	2300	60
J. K. Dering Coal Co., Clinton, Ind.	90°	274	3,400	6,200	1370	300	514	2200	60
Central Coal Co., Kimberly, Ala.		575			800	300	600	220	60
Victor American Fuel Co., Trinidad, Colo.	Slope	2600	70,000	36,000	600	300	600	440	60
Victor American Fuel Co., Gallup, N. M.	Slope	3600	76,000	36,000	600	300	600	440	60
Rock Island Mining Co., Hartshorne, Okla.	90°	650	2,600	8,450		300	450	440	60
Kemmerer Coal Co., Kemmerer, Wyo.	14½°	1450	42,000	22,000	600	300	450	2200	60
Pennsylvania Coal & Coke Co., Beaverdale, Pa.	3½°-4½°	6000	108,000	57,000	735	300	600	2200	60
Consolidation Coal Co., Monogah, W. Va.	O. P., 8.74°	2000	126,500	58,300	600	300	600	2200	60
Consolidation Coal Co., Monogah, W. Va.	9° max.	1470	97,750	50,150	600	300	600	2200	60
United Coal Corporation, Milesville, Pa.	0.4° E 1-1°	9000	260,000	117,000	700	300	600	2200	60
Youghiogheny & Ohio Coal Co., Amsterdam, Ohio	90°	300	4,200	11,800	1050	300	600	4000	60
Lehigh Coal & Navigation Co., Lansford, Pa.	90°	1110	11,500	16,500	900	325	375	2200	25
Lehigh & Wilkesbarre Coal Co., Wanamie, Pa.	15°-50°	1475	28,000	12,000	1000	340	514	440	60
D., L. & W. R. R. Co., Plymouth, Pa.	90°	650	8,000	16,000	927	350	400	440	60
Victor American Fuel Co., Hastings, Colo.	Slope	5000	70,000	36,000	600	375	600	440	60
Victor American Fuel Co., Gallup, N. M.	Slope	5000	70,000	36,000	600	375	600	440	60
Henderson Coal Co., Gwendolen, Pa.	90°	360	5,200	10,300	1740	400	514	440	60
Lackawana Coal & Coke Co., Wehrum, Pa.	90°	271	16,000	10,000	700	400	514	2200	60
New River Co., McDonald, W. Va.	90°	453	4,200	6,700	1680	400	600	2300	60
New River Co., McDonald, W. Va.	90°	467	3,600	6,000	2000	400	600	2300	60
New River Co., McDonald, W. Va.	90°	525	3,000	9,600	1780	400	600	2300	60
New River Co., McDonald, W. Va.	90°	422	3,300	6,600	1780	400	600	2300	60
Philadelphia & Reading Coal & Iron Co., Pottsville, Pa.	11½°-18°	2360	27,200	16,800	1000	400	450	440	60
Gunn Quealy Coal Co., Gunn, Wyo.	9¼°	4000	42,000	22,000	1000	400	514	2200	60
Lehigh Coal & Navigation Co., Lansford, Pa.	73°	825	11,500	13,500	900	425	375	2200	25
New River Co., McDonald, W. Va.	90°	609	3,360	6,500	2070	450	600	2200	60
Consolidation Coal Co., Gray, Pa.	7°-20°	2700	70,000	45,000	800	450	450	2200	60
Monroe Coal Mining Co., Naut-Y-Glo., Pa.	90°	411	3,360	21,000		460	450	2200	60
Vandalia Coal Co., West Terre Haute, Ind.	90°	280	6,000	7,000	1560	500	450	2200	60
Kemmerer Coal Co., Sublet, Wyo.	18°	4000	50,000	25,000	1200	500	450	2200	60
Spring Canyon Coal Co., Storrs, Utah	8°	6000	72,000	56,000	1000	500	450	2200	60
Bulah Shaft Coal Co., Raney, Pa.	90°	215	4,480	15,500		500	450	2200	60
D., L. & W. Coal Co., Nanticoke, Pa.	4½°-30°	4000	40,000	15,000	1200	600	400	440	60
Victor American Fuel Co., Gallup, N. M.	Slope	6000	95,000	45,000	600	600 {300 300}	600	440	60
New River Co., McDonald, W. Va.	90°	695	3,360	6,500	2400	600	600	2200	60
D., L. & W. Coal Co., Plymouth, Pa.	90°	1660	8,000	16,000	1440	600	400	440	60
D., L. & W. Coal Co., Plymouth, Pa.	21°	2500	36,000	14,400	1000	600	400	440	60
Lehigh Coal & Navigation Co., Hazelton, Pa.	37°	1650	12,700	10,000	1710	675	450	2200	60
Keystone Coal & Coke Co., Greensburg, Pa.	2½°-3½°	8750	240,000	100,000	1000	700	300	2200	60
Bessemer Coal & Coke Co., Russelton, Pa.	90°	290	6,000	16,500		700	400	2300	60
Union Colliers Co., Pittsburgh, Pa.	90°	540	7,000	16,000		700	400	2300	60
Lehigh Coal & Navigation Co., Lansford, Pa.	90°	900	11,500	16,500		750	300	2200	25
D., L. & W. Coal Co., Hampton, Pa.	90°	550	34,000	17,000	740	800	225	2200	60
Lehigh Coal & Navigation Co., Lansford, Pa.	90°	865	30,000	17,000	1100	1200	300	2200	25
Tennessee Coal, Iron & Railway Co., Muscoda, Ala.	23½°	5280	26,880	13,440	2700	1800	360	2200	60

APPROXIMATE LIST OF ELECTRIC COAL MINE HOIST D-C. MOTORS 200 H.P. AND ABOVE

Name of Company and Location of Mine	Inclination to Horizontal	Max. Depth in Feet	Material Per Trip in Lb.	Wt. of Skip or Cars and Cage	Rope Speed in Feet	Hoist Motor Rating in H.P.	Hoist Motor Speed in R.P.M.	MOTOR-GENERATOR SET				
								Motor			Generator	Flywheel
								Voltage	Rating in H.P.	Speed in R.P.M.	Voltage	Weight in Lb.
Colorado Fuel & Iron Co., Denver, Colo.	90°					250	90	440	125	900	260	6500
Cambria Coal Co., Royalton, Ill.	90°	280	7,000	10,000	910	250	600	2200	200	900	250	6000
Union Pacific Coal Co., Cheyenne, Wyo.	8°	4000	67,200		1200	250	600				250	Sin. mtr.
Silver King Coalition Mines, Park City, Utah	90°	1100	6,000	3,300	1630	300	65	2200	240 kv-a.	720	600	Syn. mtr.
Osage Coal Mining Co., McAlester, Okla.	90°	720	8,350	5,500	1140	350 {175 175}	} 350					
N. River & Pocahontas Consol. Coal Co., Herberton, W. Va.	90°	420	3,000	8,000	2200 max.	380	88	2200	850 kv-a.	720	275	Syn. mtr.
National Mining Co., Morgan, Pa.	90°	350	4,000	10,900	1765	500	600	2300	425 kv-a.	900	300	Syn. mtr.
Vandalia Coal Co., Terre Haute, Ind.	90°	300	5,000	13,500		675	400	2300	425 kv-a.	900	550	Syn. mtr.
Vandalia Coal Co., Terre Haute, Ind.	90°	392	5,000	13,500		800	350	2300	500 kv-a.	720	550	Syn. mtr.
Vandalia Coal Co., Terre Haute, Ind.	90°	392	5,000	13,500		800	350	2300	500 kv-a.	720	550	Syn. mtr.
Middle Fork Mining Co., Benton, Ill.	90°	650	8,000	11,000		1150	100	2200	600	720	450	25,000
Christopher Coal Co., Christopher, Ill.	90°	687	9,000	11,000	2400	1150	109	2300	650	600/510	550	22,600
Peabody Coal Co., Nokomis, Ill.	90°	687	16,000	19,000	1950 max.	1300	57	2300	950	514/435	550	33,000
Consolidation Coal Co., Fairmont, W. Va.	90°	559	6,500	14,800		1400	90	2200	600	720	550	29,000
Consolidation Coal Co., Fairmont, W. Va.	90°	529	6,500	14,800		1400	90	2200	600	720	550	29,000

WESTINGHOUSE ELECTRIC & M'F'G CO.

EAST PITTSBURGH, PA.

SALES OFFICES

Atlanta, Ga.
Baltimore, Md.
Birmingham, Ala.
Bluefield, W. Va
Boston, Mass.
Buffalo, N. Y.
Butte, Mont.
Charleston, W. Va.
Charlotte, N. C.
Chicago, Ill.
Cincinnati, Ohio.
Cleveland, Ohio.
Columbus, Ohio.
Dallas, Tex.
Dayton, Ohio.
Denver, Colo.
Detroit, Mich.
*El Paso, Tex.
*Houston, Tex.
Indianapolis, Ind.
Joplin, Mo.
Kansas City, Mo.
Louisville, Ky.
Los Angeles, Cal.
Memphis, Tenn.
Milwaukee, Wis.
Minneapolis, Minn.
New Orleans, La.
New York, N. Y.
Omaha, Neb.
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Ore.
Rochester, N. Y.
St. Louis, Mo.
Salt Lake City, Utah.
San Francisco, Cal.
Seattle, Wash.
Syracuse, N. Y.
Toledo, Ohio.
Washington, D. C

*W. E. & M. Co., of Texas.

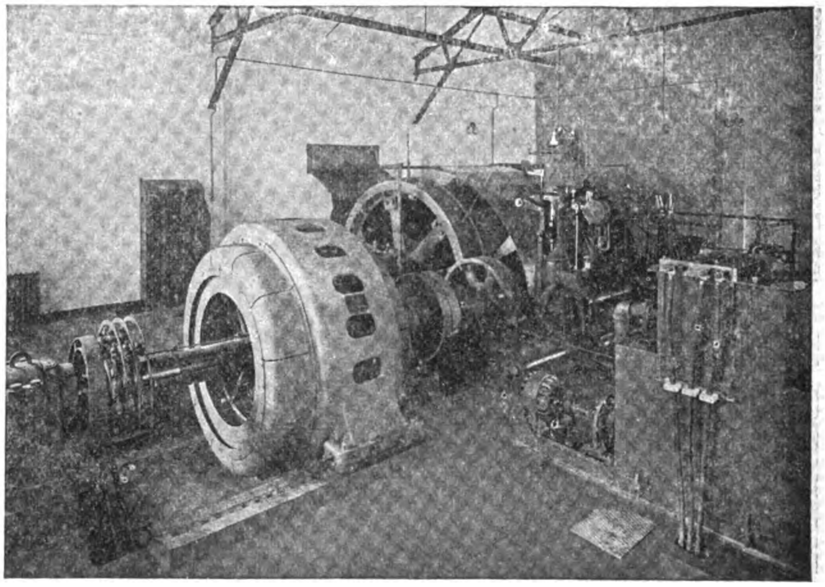
Westinghouse Induction Motors for Hoisting and Similar Service

Products

Electrical Equipments for all mining apparatus.

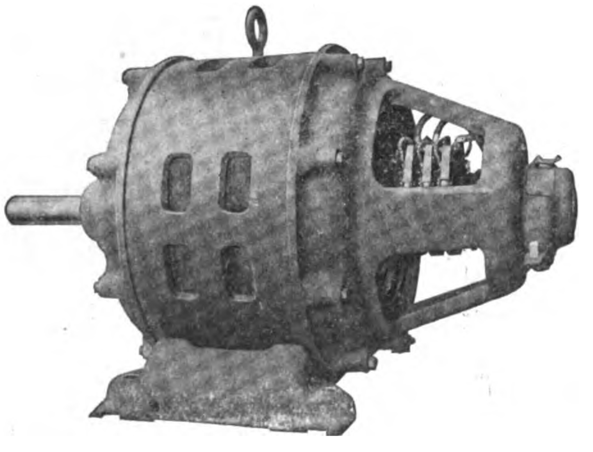
Type CI With Wound Secondaries

These motors have strong starting torque for starting heavy loads, especially in reversing service. The rotors are small in diameter, permitting ready braking and quick reversal.



200 H. P. Type C. I. Motor, Showing Massive Frame Construction.

In general the mechanical construction is similar to our squirrel cage induction motors type CS, except for the rotor winding, embodying the latest methods of construction, such as pressed or rolled steel instead of cast iron, etc. Form wound coils are used throughout, making possible quick repairs in case of accident. The bearings are very liberal and the air gap is large, giving unusually long life.



75 H. P. Type C. I. Motor, Showing Rolled Steel Frame Construction.

These motors are built for 60 cycle circuits, two or three phase, 220 and 440 volts, and 3 phase 550 volts. Motors for 2200 volts 3 phase can be supplied in most sizes.

RATINGS

H. P.	APPROXIMATE FULL LOAD SPEEDS.			
75	900	720	600	
100		720	600	
150		720	600	
200			600	514
250			600	514
300			600	514

MEDART PATENT PULLEY CO.

Main Office and Factory
ST. LOUIS, MO., U. S. A.
Branch House, Cincinnati, Ohio. Engineering Sales Office, Chicago, Ill.

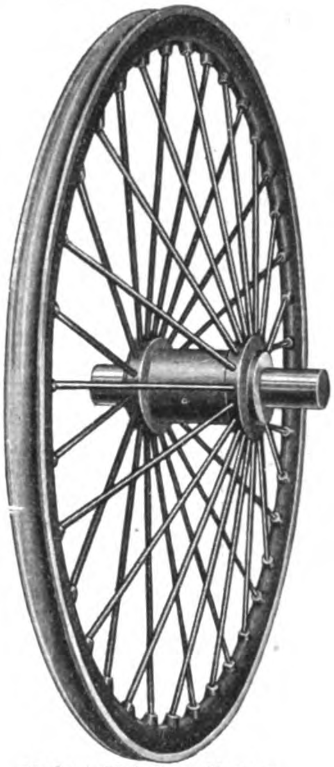
Manufacturers of

Power Transmitting Appliances

Products

Steel Rim, Cast Iron and Wood Split Pulleys, Shafting, Friction Clutches, Hangers, Couplings, Pillow Blocks, Rope Transmission, Gearing, Sprocket Wheels, Hoisting Sheaves, etc.

Medart Hoisting Sheaves


Medart Hoisting Sheave, Bicycle Type.

Along with rope transmission machinery we have developed a full line of hoisting sheaves, specializing in the Bicycle Type shown in the illustration. This sheave has all the strength of the plain types, with the added advantages of offering great resistance to shock or jar, and of being lighter. It can be equipped with either rubber, wood-lined or turned groove. Like our other products, we guarantee our sheaves to come up to our Catalog representation, or we will replace them free of charge, or refund the money paid for them.

Steel Rim Pulleys

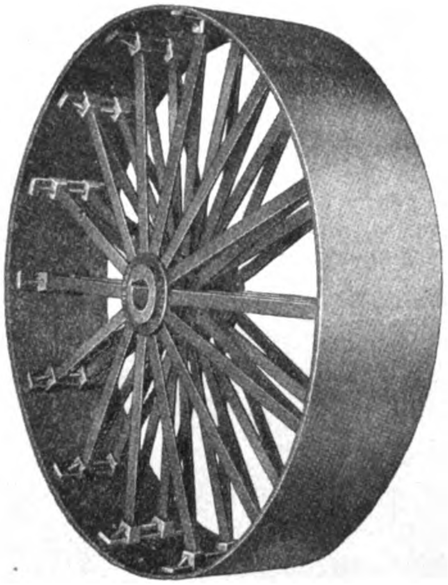
For strength, balance, durability and time running qualities MEDART Steel Rim Pulleys are unexcelled. They are constructed with cast iron hubs and arms with Steel Rims strongly riveted. Thus constructed, they are absolutely free from shrinkage strains, are not liable to fly apart from centrifugal force, and are particularly adapted for high speeds.

They are guaranteed for the duty for which they may be ordered, and should they fail from belt strains, will be replaced without charge.

Hercules Pulleys

MEDART Hercules Pulleys are constructed for special heavy service, and are guaranteed to do the work when all others fail. The arms are made of flat steel bars, rims of heavy plate and hubs and lugs of semi-steel when required.

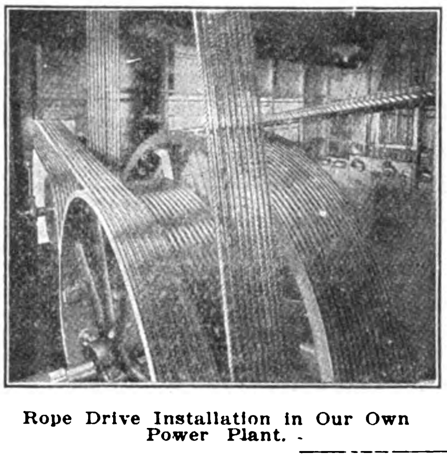
Tell us the conditions, and we will design and guarantee this pulley to do the work. It is made whole or split, 3 feet to 15 feet in diameter, any width face up to 50 inches. Arms, hub and lug dimensions, and thickness of rim may be changed to suit conditions; therefore, MEDART Hercules Pulley is the best on the market for special heavy service.


Hercules Double Arm Whole Pulley.

Rope Drives

We have made a specialty of Manilla Rope power transmission for many years, and will gladly make designs for the suitable arrangement of Rope drives which will insure proper and satisfactory operation and will give the expected results.

Every installation of rope transmission presents problems peculiar to itself, which can be solved satisfactorily only by an extert in that branch of engineering. Our Engineering Department will gladly give expert advice free of charge when our equipment is considered.


Rope Drive Installation in Our Own Power Plant.

THE EVERHART BRASS WORKS

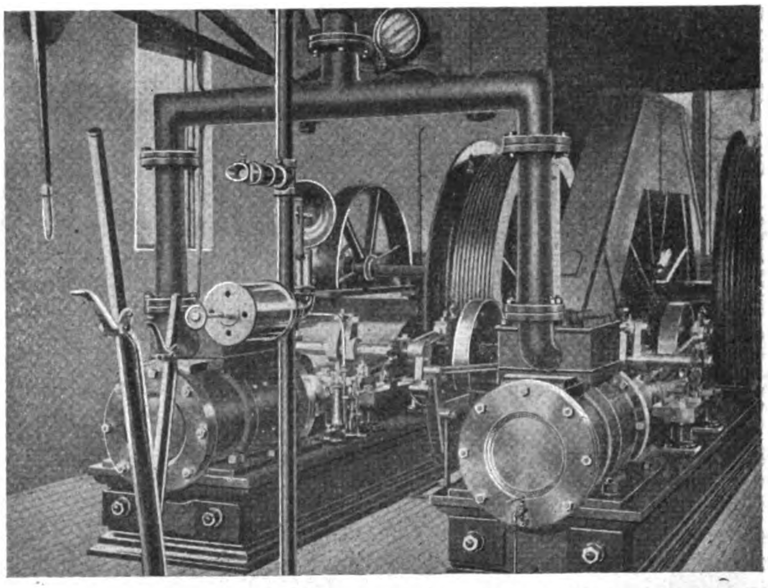
422-424 Penn Avenue, Scranton, Pa., U S. A

Products

Anemometers; Babbitt Metal; Castings, (Brass & Bronze); Gongs; Valves, (Globe, Angle and Check); Signaling Systems.

Pneumatic Signal Gong

The illustration herewith gives a clear idea of the Pneumatic Signal Gong Attachment for Speaking Tubes, and shows the outfit which is generally installed at each station or place at which signals are to be sent and received. The installation of the proper number of these attachments makes a complete hoisting and communicating system between shaft, engine house and tipple or other places as desired. The outfit as shown in the illustration herewith, consists of a heavy brass gong with stem and striker, brass air-chamber and an extra heavy brass speaking tube mouthpiece with whistle.



The air-chamber cylinder is fitted with a bronze plunger having a steel plunger rod, on the outer end of which is attached a bronze handle. The gong regularly furnished is eight inches in diameter, made of cast bell metal, and gives a loud, clear signal. The stem of the gong contains a striker which normally rests on a projection made by counterboring the stem.

Advantages

Misunderstanding of signals impossible.

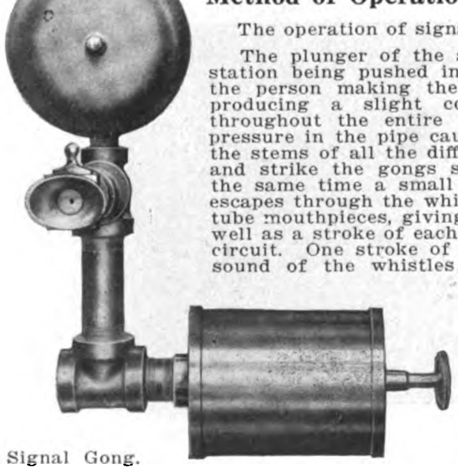
There is no possibility of either Engineer or Footman receiving different signals.

All signals are repeated **simultaneously** at all stations, clear and sharp, without the slightest echo.

There are no wires to break, to short-circuit or cross by falling material.

Maintenance cost, nothing.

Greater safety and efficiency.

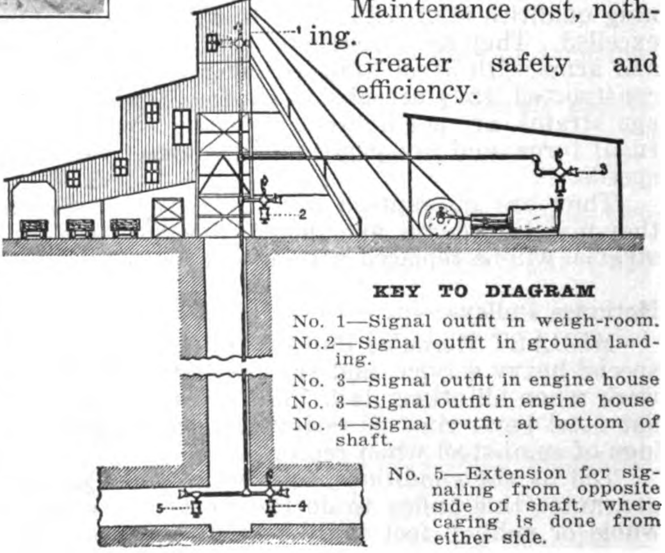


Signal Gong.

Method of Operation

The operation of signaling is as follows:

The plunger of the air-cylinder at any station being pushed into the cylinder by the person making the signal, results in producing a slight compression of air throughout the entire pipe circuit. This pressure in the pipe causes the strikers in the stems of all the different gongs to rise and strike the gongs simultaneously. At the same time a small amount of the air escapes through the whistle at all speaking tube mouthpieces, giving whistle signals as well as a stroke of each gong on the signal circuit. One stroke of the gongs and one sound of the whistles is obtained every time any one of the different air-cylinder plungers is operated. Any number of gong and whistle signals can be made by pressing the air-cylinder plunger the desired number of times.



KEY TO DIAGRAM

No. 1—Signal outfit in weigh-room.
No.2—Signal outfit in ground landing.
No. 3—Signal outfit in engine house
No. 3—Signal outfit in engine house
No. 4—Signal outfit at bottom of shaft.
No. 5—Extension for signaling from opposite side of shaft, where caging is done from either side.

THE MINING SAFETY DEVICE CO.

Office and Works
BOWERSTON, OHIO, U. S. A.
Manufacturers of

Automatic Shaft Bottoms and Dump Feeders

Products

Automatic Feeder and Cager for caging cars at shaft bottoms; Automatic Feeder for dumps and tipples.

The Automatic Caging Device

Increases mine efficiency by making quick hoisting of cars possible, and reduces operating expenses by requiring fewer men at the landing. It also prevents expensive delays caused by cars getting into the sump, and keeps men away from the shaft and danger from falling coal. It is strongly constructed of steel to meet the conditions at the mine where it is to be installed. It may be used in either coal or quartz shafts, or tipples and gravity inclines.

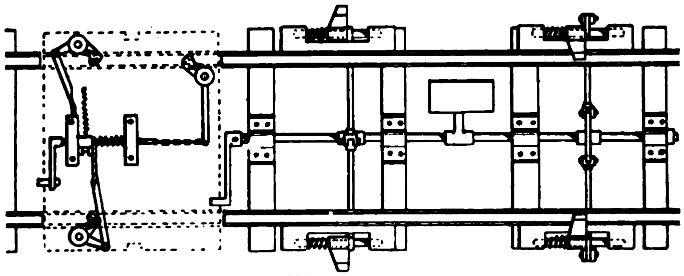


Fig. 1

Operation

The operation of the Automatic Caging Device depends upon gravity and the action of the cage. As the cage descends it depresses the lever seen at the extreme left of Fig. 2 and at the edge of the shaft (indicated by broken lines) in Fig. 1. The depression of this lever rotates the shaft to which it is attached, this action opening the forward pair of horns and closing the rear pair, at the same time raising the weight. Thus, with a trip of cars against the forward horns of the cager, the cage as it lands at the bottom opens the front horns and closes the rear horns, holding the trip in check and permitting the front car to pass onto the cage, where the Automatic Stop spots and holds the car in position.

As the cage rises its weight is taken off the lever, and the weight, no longer supported, falls, closing the front horns and opening the rear horns, permitting the whole trip to advance one car length.

Landing of the cage also opens the blocks on the cage releasing the empty car. The loaded car entering cage, displaces the empty car which closes the Automatic Stop. The Stop is again in position to take care of the loaded car.

Construction

Our Automatic Mine Car Feeder is constructed amply strong to meet the most severe conditions encountered in mines. Each set of horns on Cagers and Feeders are provided with a set of coiled springs to take up the shock and prevent damage to wheels, axles, and cars. In order to give facts and data concerning their construction it is necessary to know the length of your cars, gage of track, length of wheel base, weight of loaded car, and diameter of wheels.

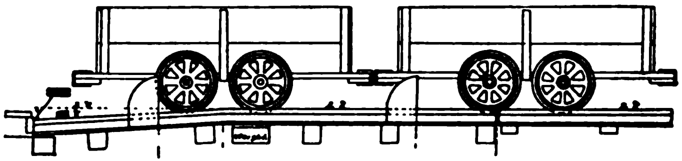


Fig. 2

Measurement blanks and approximate costs will be sent on request, as well as a list of satisfied and pleased users.

Harrisburg, Illinois, Sept. 23, 1916.

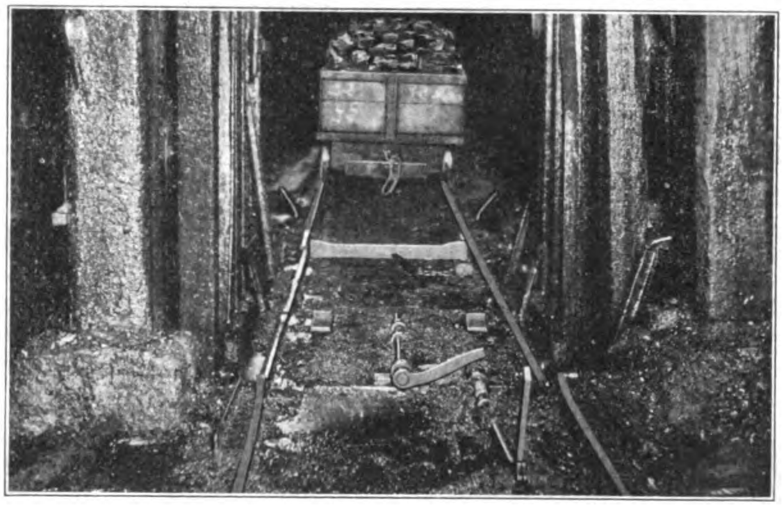
Before we installed your cager at our mine No. 3 it required three men to put the loads on the cage. Your cager has dispensed with two men and the hardest work the cager has to do is to ring the bell as the cage releases the load when landing at the bottom and the loaded car goes on the cage by gravity. We have a tonnage of from 2500 to 3000 tons per day and we have not been to any expense since the cager has been installed.

Your very truly,
SALINE COUNTY COAL COMPANY,
Per Geo. W. Morris, Superintendent.

Chicago, January 19, 1917.

Your Automatic Car Cager has proven entirely satisfactory to us which is evidenced by the fact that we have installed them in three of our mines.

Yours very truly,
(Signed) J. K. DERING, Pres.



This picture shows one of the tracks at a shaft bottom, cage down.

ESTABLISHED 1900.

ROYER AND ZWEIBEL

WILKES-BARRE, PA.

Manufacturers of the

ROYBEL Emergency Governor

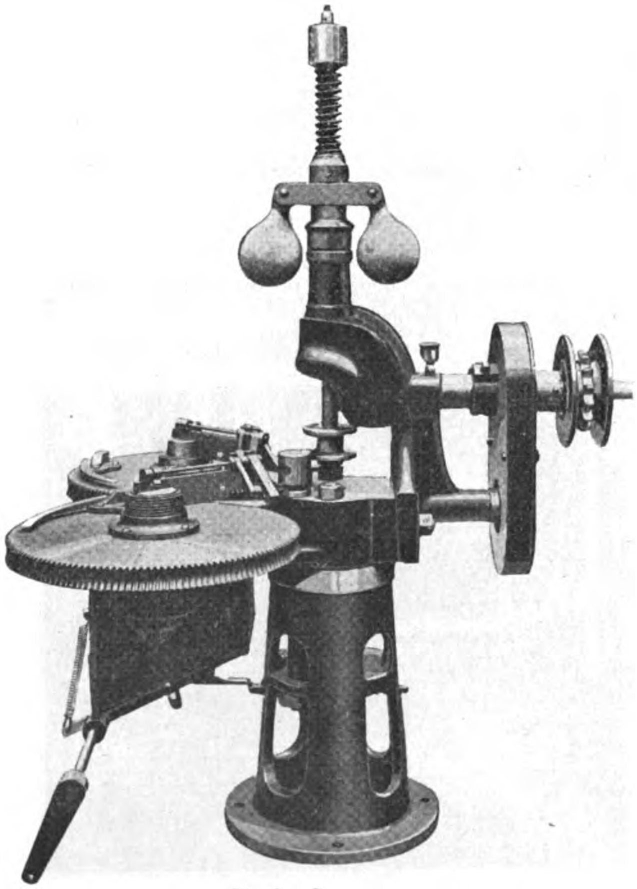
Positively Prevents Overwinding, Overspeeding or Passing the Ground Level When Hoisting Men

Equally as efficient on steam or electric hoists, or a haul of one hundred or ten thousand feet. Is reset and tested from the station of the engineer in five seconds, and is a safety device. SAFE first within itself by being BUILT RIGHT.

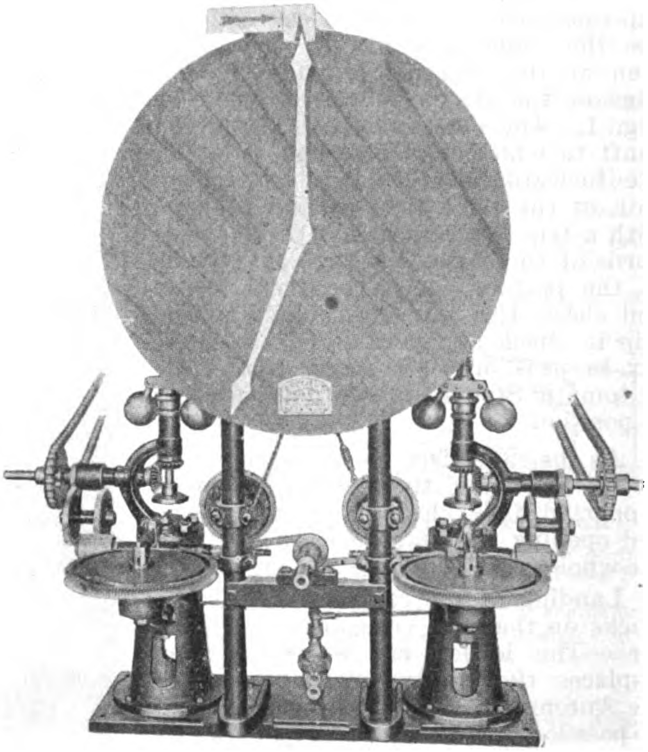
WE Install Either Governor Subject to the Approval of Your Engineer

Our governors are indorsed and used by the leading hoist builders, and many REPEAT ORDERS, from the large Coal Companies, warrants us in installing our governor subject to your APPROVAL.

When ordering a new Hoist, and you desire to be insured against OVERWINDING or OVERSPEEDING, specify the ROYBEL Emergency Governor.



Single Governor.
For single or keyed drums.



Double Governor.
For double or clutch drums.

S. C. WEBB COMPANY

Box 48

WILKES-BARRE, PA.

The Webb Hoist Recorder

Is your hoist being worked to its full maximum capacity? If not you are losing money.

The Webb Recorder will give you an accurate, indesputable record of just what your engineer is doing.

What It Does

The information recorded on the daily sheets will show you every movement of your cages, whether day or night. Each sheet will give you the following valuable information:

(1) Time each trip was started.

(2) Time each trip was landed.

(3) Exact time and duration of all delays.

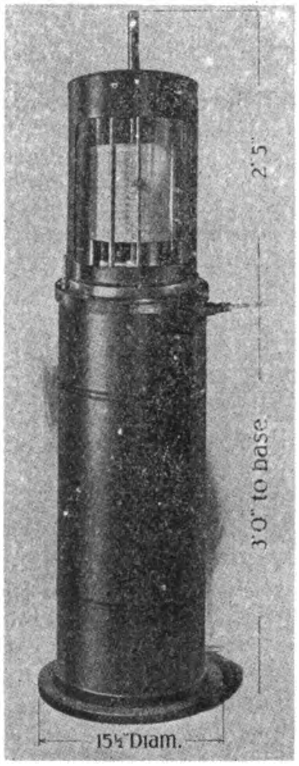
(4) Whether or not ropes and guides were inspected as required by law.

(5) Total trips made per day.

(6) show from which level hoist was made.

(7) Rope speed of hoist.

(8) When and how many times the cage overtraveled.



The capacity of the hoist can be increased by referring to the charts and eliminating causes for delays. This is not theory but has been demonstrated in actual practice. The moral effect that this instrument has on the operator is conducive to a higher operating efficiency.

In case of a serious accident, such as overwinding, the information on the chart would be very valuable.

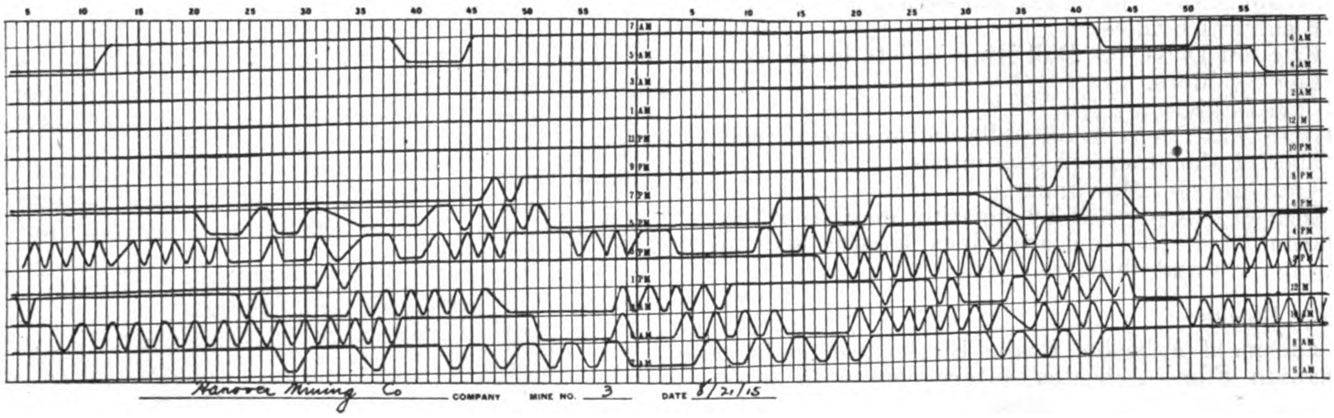
An actual chart will be sent on request.

Information Required With Order

Diameter of shaft on which driving sprocket is mounted.

Number of turns driving shaft makes when hoisting from maximum depth.

Approximate distance recorder will be located from driving shaft.



This is an actual reproduction of a chart taken with the fecorder. It shows the total number of trips made, time idle, and just when each trip was started and landed.

The instrument can be attached to any type of hoits, steam or electric, without any alterations whatever. All necessary chain, sprockets, etc., for drivinga are included in price.

If desired, the outfit can be arranged at an additional charge for recording the signal given to the operator where electric signaling is used. This feature shows just what material was hoisted, from where, and at what time the signal was given.

Cost

Recorder complete, with a month's supply of 24-hour charts, $150.00; same instrument with device for recording signals, $180.00, f. o. b Wilkes-Barre, Pa.

THERMOID RUBBER COMPANY

Factories and Main Offices

Trenton, New Jersey, U. S. A.

BRANCHES

Chicago, Ill.
Philadelphia, Pa.
Indianapolis, Ind.
Coventry, England

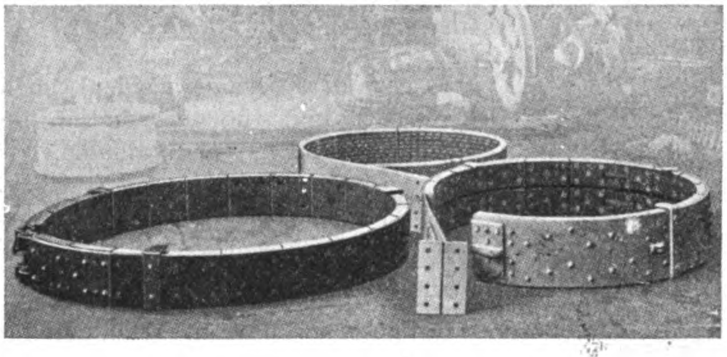
San Francisco, Cal.
Boston, Mass.
New York, N. Y.
Cleveland, Ohio

Pittsburgh, Pa.
St. Louis, Mo.
Detroit, Mich.
Paris, France

Manufacturers of Thermoid Products

Products

Thermoid Asbestos Brake Blocks, Clutch Blocks, Thermoid Brake Lining, Clutch Facings and Discs.



Where Used

- Gas Engines.
- Elevators and Dynamos.
- Cableways, Inclines.
- Cranes, steam and electric; Stationary Overhead Traveling and Locomotive Cranes.
- Hoists, steam and electric; Hoisting Engines at mines and quarries.
- Steam Shovels in mines and excavation work.
- Electrical Brakes.
- Friction Drive for Bull Ring Hoists in mines.
- Log Skidders.
- Coal Chutes in mines.
- Drill Machinery in oil wells and prospect drills.
- Special Machinery in coal mines.
- Transmission Machinery.
- Derricks—Operated by hoisting engines in excavation work, coal and ore mines, loading and unloading cars and ships.

Brake Blocks

Thermoid Asbestos Brake Blocks are made of Canadian Fibre Asbestos, interwoven with brass wire.

Thermoid Brake Lining and Blocks are impregnated throughout with Grapnal. This exclusive process makes it impervious to gasoline, oil, water, dust, etc. No other brake lining or blocks are Grapnalized—or can be. That is why ordinary brake lining will not, and cannot, give the length of life and service that Thermoid Brake Lining and Blocks give.

Powerful hydraulic presses compress Thermoid into a solid mass. This makes it far tougher and stronger than ordinary linings. It makes the wearing surface ideal for braking; it can't grab and it can't slip. The "coefficient of friction" is just right.

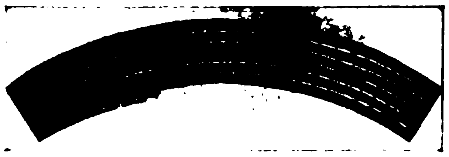
Blocks are made in special moulds, in any size and shape, and can be furnished to accurately fit any kind of machinery. Send us a drawing or blue print showing the construction of brake for our recommendation and quotations. We have the moulds of hundreds of special shapes for popular makes of all kinds of industrial machinery.

Friction Clutches

Thermoid Asbestos Clutch Blocks, Facings and Discs are also made from Canadian Fibre Asbestos, reinforced with brass wire as is regularly used in Thermoid brake lining. They are not made from scrap or short fibres ground to a pulp and cast into moulds.

Brake Lining

Ten years of practical tests on every kind of machinery using brake lining has proven that Thermoid Compressed Brake Lining is the most efficient, and will outwear any brake lining, foreign or domestic, or any other brake material.



Thermoid Hydraulic Compressed Brake Lining is flexible and conforms readily to the shape of, and is easily fitted to brake band or drum, presenting a smooth, uniform wearing surface.

Our Guarantee

Thermoid will make good—or WE WILL. It is positively guaranteed to out-wear and give better satisfaction than any other brake lining.

Our engineering department is at your service.

INTERSTATE EQUIPMENT CORP.

Main Office

10 WALL ST., NEW YORK

LICENSED UNDER LAWSON PATENTS FACTORY, ROANOKE, VA.

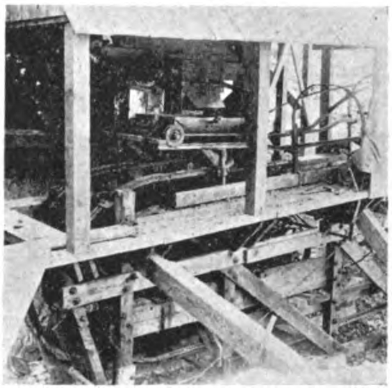
Automatic Wire Rope Tramways

Simple to Install. Minimum of Power Required. Operated by Unskilled Labor. Low Operating Cost and Upkeep.

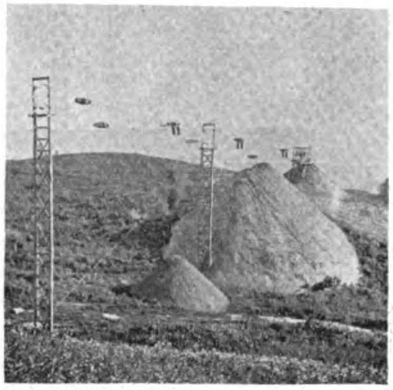
Prompt Shipment of Standard Lines

Our Engineering Department Will Design Special Equipment for Difficult Hauling Problems.

Hauling coal in West Virginia from mine opening to siding. Operates by gravity.



Loading car automatically transfers charge during short travel with continuously moving tram car, returning empty by gravity for new charge.



Automatic aerial dump for storing material along line. Note load falling to first storage pile.

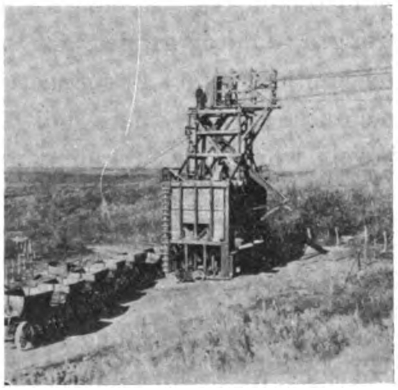
Hauling gypsum. Curve at river crossing.

Ascending in rough country over highway and railroad.

Simple but substantial towers.

Loading bin on mountain side by scrapers. Note discharge terminal and bin in valley.

Long span twin lines hauling 1,500 tons of clay per day for brick plant.



Automatic dumping terminal with screens and bins for road building plant.

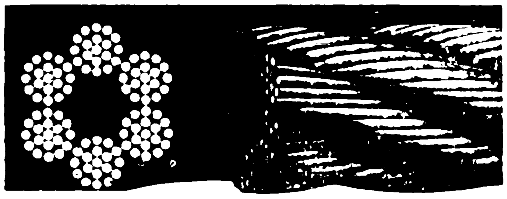
AMERICAN STEEL & WIRE CO.

Sales Offices:

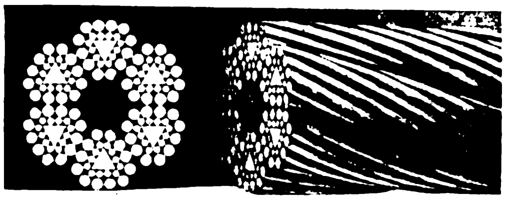
CHICAGO	208 So. La Salle Street	CLEVELAND	Western Reserve Building
NEW YORK	30 Church Street	BALTIMORE	32 So. Charles Street
WORCESTER	94 Grove Street	WILKESBARRE, PA	Miners Bank Building
BOSTON	120 Franklin Street	ST. LOUIS	3d National Bank Building
PHILADELPHIA	Widener Building	ST. PAUL-MINNEAPOLIS	Pioneer Bldg., St. Paul
PITTSBURGH	Frick Building	OKLAHOMA CITY	State National Bank Building
BUFFALO	337 Washington Street	BIRMINGHAM, ALA	Brown-Marx Building
DETROIT	Foot of First Street	DENVER	1st National Bank Building
CINCINNATI	Union Trust Building	SALT LAKE CITY	Walker Bank Building

Export Representative: U. S. Steel Products Co., New York
Pacific Coast Representative: U S. Steel Products Company
San Francisco Los Angeles Portland Seattle

AMERICAN WIRE ROPE



STANDARD HOISTING ROPE.
6 Strands, 19 Wires, 1 Hemp Core.



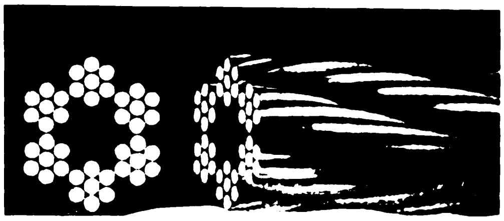
FLATTENED STRAND ROPE.
6 Strands, 25 Wires, 1 Hemp Core.

For Mine Hoists

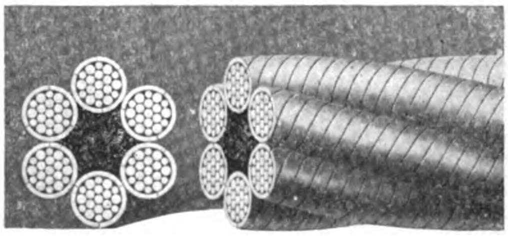
In mine shaft the Standard Hoisting Rope shown above is almost universally used. Crucible and Extra Strong Crucible grades are most popular, but Plow Steel is sometimes employed, especially where the load is heavy. Standard Hoisting Rope in high strength Monitor grades are used (in ½ and ⅝ inches in diameter) in connection with coal cutting machines, also as main hoisting rope on steam shovels where the stripping process of mining is employed.

For Haulage and Tail End Purposes

The Haulage Rope is best suited. We make these ropes in many different constructions and of several grades of wire depending upon conditions at the mine.



HAULAGE ROPE.
6 Strands, 7 Wires, 1 Hemp Core.



STEEL CLAD ROPE.
Note Exterior Serving of Flat Steel.

For Steam Shovels

The Flattened Strand and Steel Clad Ropes are generally being particularly well adapted to the heavy strains and abrasion encountered in this class of work.

Stocks

Carried with jobbers and dealers in all mining communities also in our own warehouses at Chicago, New York, Pittsburgh, Buffalo, Cleveland and St. Louis.

BRODERICK & BASCOM ROPE CO.

New York ST. LOUIS Seattle

FACTORIES, ST. LOUIS AND SEATTLE. AGENTS IN ALL LOCALITIES.

Manufacturers of Celebrated Yellow Strand Wire Rope

Don't talk "Safety First" to your employes and then go out and buy cheap wire rope.

"Safety First" means, "Use B. & B. Wire Ropes."

These high quality ropes cost no more than ordinary kinds, yet as a safety factor in coal mines they must necessarily be far superior.

You'll never realize the vast difference in ropes of various manufacture until you buy and try

BRODERICK & BASCOM

WIRE ROPES

especially constructed to withstand the severe shocks, strains, tortions and high speeds incident to operation in coal mines—shaft, slope haulage or inclined plane.

Consider the manufacturers, with "quality" reputation extending back through more than 40 years.

Consider the wide use to which B. & B. ropes have been put during that long period—logging, coal and copper mining, oil well drilling, big engineering and construction work everywhere, including the Panama Canal and some of the largest dams and tallest office buildings in this country.

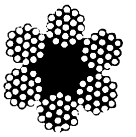
Consider the tremendous success which has attended the use of B. & B. ropes in all this variety of particular and important work.

Then, consider if B. & B. Wire Ropes are not exactly the ropes you can best trust with the lives of your men. You know they are.

Buy from our agent nearest you, or direct.

Ever since 1904 the Broderick & Bascom Rope Co. has been carrying off the bacon in the form of Gold Medals and Grand Prizes at the big Expositions throughout the country. Here's the list:

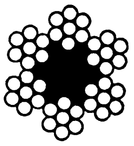
1904	Grand Prize for Wire Ropes, Louisiana Purchase Exposition, St. Louis.
1905	Gold Medal, highest award for Wire Ropes, Lewis & Clark Exposition, Portland.
1909	Gold Medal for Wire Ropes, Alaska-Yukon-Pacific Exposition, Seattle.
1915	The only Grand Prize for Wire Ropes, Panama-Pacific International Exposition, San Francisco.
1915	Gold Medal for Basline Autowline and Powersteel Autowlock, Panama-Pacific International Exposition, San Francisco.



Plow Steel Hoisting Rope

6 strands, 19 wires per strand, around a hemp center.

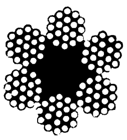
Diameter in inches.	List price per foot.	Circumference in inches.	Approximate weight per foot.	Approximate strength tons of 2000 lbs.	Proper work'g load in tons 2000 lbs.	Diam. of drum or sheave in feet advised.
¼	$ .12	¾	.10	2.65	.53	1
5/16	.12¼	1	.15	3.8	.76	1.25
⅜	.12½	1⅛	.22	5.75	1.15	1.50
7/16	.13	1¼	.30	8	1.6	1.75
½	.14	1½	.39	10	2	2
9/16	.16	1¾	.50	12.3	2.4	2.25
⅝	.19	2	.62	15.5	3.1	2.5
¾	.26	2¼	.89	23	4.6	3
⅞	.34	2¾	1.20	29	5.8	3.5
1	.43	3	1.58	38	7.6	4
1⅛	.54	3½	2	47	9.54	4.5
1¼	.65	4	2.45	58	12	5
1⅜	.79	4¼	3	72	14	5.5
1½	.93	4¾	3.55	82	16	6
1⅝	1.08	5	4.15	94	19	6.5
1¾	1.30	5½	4.85	112	22	7



Plow Steel Haulage Rope

6 strands, 7 wires per strand, around a hemp center.

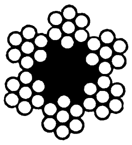
9/32	$ .05½	⅞	.12½	3.4	.68	1¾
5/16	.06	1	.15	4.4	.88	2¼
⅜	.06¾	1⅛	.22	5.9	1.2	2¾
7/16	.09	1¼	.30	7	1.4	3
½	.11½	1½	.39	10	2	3½
9/16	.14½	1¾	.50	12	2.4	4
⅝	.17½	2	.62	16	3.2	4½
11/16	.21	2⅛	.75	18	3.6	4¾
¾	.24½	2¼	.89	23	4.6	5
⅞	.32	2¾	1.20	31	6.2	6
1	.41	3	1.58	38	7.8	7
1⅛	.51	3½	2	47	9.8	8
1¼	.62	4	2.45	60	12.4	9
1⅜	.76	4¼	3	72	14.6	10
1½	.90	4¾	3.55	82	16.8	11



Crucible Cast Steel Pliable Hoisting Rope

6 strands, 19 wires per strand, around a hemp center.

Diameter in inches.	List price per foot.	Circumfer. in inches.	Approx. weight per foot.	Approx. streng. tons 2000 lbs.	Prop. work load tons 2000 lbs.	Diam. drum or sheave in feet advised.
¼	$ .09	¾	.10	2.2	.44	1
5/16	.09¼	1	.15	3.1	.62	1.25
⅜	.09½	1⅛	.22	4.8	.96	1.50
7/16	.10	1¼	.30	6.5	1.30	1.75
½	.11	1½	.39	8.4	1.68	2
9/16	.12	1¾	.50	10	2	2.25
⅝	.14	2	.62	12.5	2.5	2.5
¾	.19	2¼	.89	17.5	3.5	3
⅞	.24	2¾	1.20	23	4.6	3.5
1	.31	3	1.58	30	6	4
1⅛	.38	3½	2	38	7.6	4.5
1¼	.46	4	2.45	47	9.4	5
1⅜	.56	4¼	3	56	11.2	5.5



Crucible Cast Steel Haulage Rope

6 strands, 7 wires per strand, around a hemp center.

7/16	.06½	1¼	.30	5.5	1.1	3
½	.08	1½	.39	7.7	1.5	3½
9/16	.10	1¾	.50	10	2	4
⅝	.12	2	.62	13	2.6	4½
11/16	.14½	2⅛	.75	15.4	3.1	4¾
¾	.17	2¼	.89	18.6	3.7	5
⅞	.22½	2¾	1.20	24	4.8	6
1	.29	3	1.58	31	6.2	7

FISCHER & HAYES ROPE COMPANY

604 West Lake Street CHICAGO

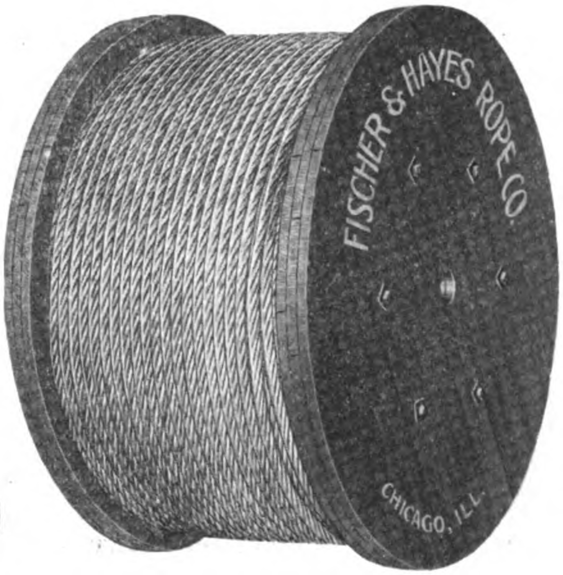
Wire Rope

Products

High grade iron and steel wire rope for all manner of wire rope uses. Manila rope for hoisting and power transmission. Wire strand. A complete line of wire rope accessories.

Wire Rope For All Purposes

Wire Rope for Hoisting, Haulage, Excavating, Conveying, Cable-ways, Power Transmission, Aerial Tramways, of various degrees of toughness, ductility, flexibility and tensile strength, to meet all manner of working conditions with a maximum degree of service.



Service

The severity of service to which wire rope is put in mine work and the varying conditions met with in mine hoisting and haulage operations make the selection of wire rope for mine usage an important and difficult work. Without any obligation whatsoever we will gladly render any assistance in our power to aid mine officials in determining the most satisfactory rope to use for the particular hoisting or haulage system and conditions existing at your particular mine. Inquiries and requests for information promptly answered.

For Mine Hoisting—Atlas Improved Plow Steel Hoisting Rope

Where drums and sheaves sufficiently large are used, Atlas Improved Plow Steel Hoisting Rope is recommended as dependable, long lasting and safe—for hoists of both men and material. Constructed with 6 strands, 19 wire to the strand, around a hemp core, and to withstand the severe abrasive tendencies so detrimental to rope in mine hoisting service. If conditions make a rope of greater flexibility advisable—for smaller drums or sheaves—we furnish a special cast steel hoisting rope that will deliver a maximum service for this class of work.

Atlas Improved Plow Steel Hoisting Rope.

For Mine Haulage—Fischer-Hayes Special Haulage Rope

Constructed with 6 strands, 7, 12 or 19 wires to a strand, around a hemp center. Supplied in a variety of different grades, to meet the various conditions existing at the mine and for any mine haulage system—endless, tail-rope or gravity plane systems.

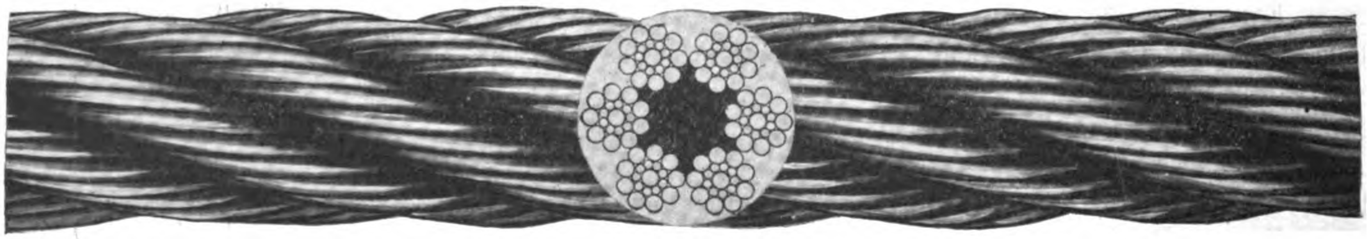
Fischer-Hayes Special Haulage Rope.

Wire Rope For Other Mine Equipment

Wire rope for shovels, digging, tramways, handling and conveying of materials and aboveground mine operations as well as those under ground.

Accessories

We aim to keep in stock for prompt shipment a complete supply of TURNBUCKLES, BLOCKS, SHEAVES, CLIPS, THIMBLES, MANILA ROPE, WIRE STRAND, LUBRICANTS and other wire rope supplies.



HAZARD MFG. COMPANY

WILKES BARRE, PA.

NEW YORK
533 Canal Street

PITTSBURGH
1st Nat'l Bank Building

CHICAGO
552 W. Adams Street

**HOISTING
AND
HAULAGE
ROPES**

HAZARD
WIRE ROPE

**GALVANIZED
STRAND
HAND FORGED
FITTINGS**

MADE FOR USERS WHO WANT THE BEST

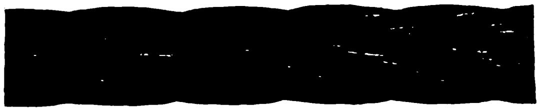
Products

Wire Rope, Galvanized Strand and Fittings.

The following sections show the various ropes applicable to mine use.

HAZARD Standard Hoisting Rope.

HAZARD Flexible Hoisting Rope.



HAZARD Cable Construction Rope.
(Seal Patent)

HAZARD Haulage Rope, Regular Lay.

HAZARD Haulage Rope, Lang Lay.

HAZARD Swedes Iron Wire Rope

Is made from the Best Swedish Iron, imported by us in the form of rods, drawn and finished into Wire in our own Wire Mill. It is made according to standards of material and construction that are uncheapened under competition, and gives the best value, because the best is the cheapest.

HAZARD Cast Steel Wire Rope

Is made from the best steel obtainable in the markets of the world for Wire Rope use. It is unexcelled because it contains the best material and is constructed by methods embodying the best skill and workmanship which have been developed in this country. The HAZARD MANUFACTURING COMPANY has never cheapened or lowered its standards of material or construction.

HAZARD Plough Steel Wire Rope

Is made from the best Plough Steel that is to be obtained in the markets of the world. It stands for absolute fidelity to the best standards of construction and material. It gives the best results under listed conditions of load, diameter of drums and sheaves that can be secured at the price charged.

HAZARD "Olympic Brand" Wire Rope

Represents the latest and best development in the adaptation of steel to Wire Rope use. It is made with breaking strains 15 to 20 per cent above the strains given in our regular Plough Steel Wire Rope lists. The Wire is specially treated in our Tempering Mill and Wire Mill for the greatest obtainable strength.

HAZARD Extra Galvanized Special Strength Strand

Is made in three grades of strength and quality; **Siemens-Martin Steel, High Strength** and **Extra High Strength.** It is the best Galvanized Strand that can be made in the three grades of strength. It is sold by special list with **guaranteed weights and strains,** subject also to the A. T. & T. Co., Western Union and Postal Telegraph Companies' specifications for galvanizing.

HAZARD Extra Galvanized Special Strength Strand.

HAZARD Hand Forged Wire Rope Fittings

Are made to meet the demand for Fittings which are absolutely reliable, to be used on Wire Ropes.

These Fittings are made of the finest quality of Imported Triple Refined Iron, in our own blacksmith shop. They are made extra heavy and of proper dimensions to develop the maximum breaking efficiency of the Wire Rope with which they are designed to be used.

A. LESCHEN & SONS ROPE CO.

ST. LOUIS, U. S. A.

Branch Stores:
NEW YORK CHICAGO DENVER SALT LAKE CITY SAN FRANCISCO

MANUFACTURERS OF

High Grade Wire Rope for All Purposes--Aerial Wire Rope Tramways

Products

Wire Rope for all purposes, of both special and stadard grades and constructions, including the famous HERCULES (Red Strand) Wire Rope, Wire Ropes of Patent Flattened Strand construction, Locked Coil Wire Ropes and Locked Coil Cables; Wire Rope Blocks, Clips, Thimbles, Sockets and Hooks; Wire Rope Lubricants; Aerial Wire Rope Tramways.

Design and Workmanship

Every process in the manufacture of Leschen Wire Rope is according to our own exclusive methods, and is accompanied by exacting tests and rigid inspections. Each rope is made to conform to the design that we have found from experience to be best for the particular work the rope is to perform, and the remarkable success of Leschen wire rope is in no small measure due to its special method and manner of construction.

Quality of Material

Leschen Wire Ropes for mining are furnished in the following grades: HERCULES (Red Strand) Wire Rope, Special Steel, Plough Steel and Cast Steel.

Hercules Wire Rope

This is a rope of the very highest quality. It represents the correct combination of strength, elasticity, toughness and flexibility for maximum service. It is the best that can be bought at any price, and because of its durability it is the most economical rope for heavy work, that can be obtained. It is recommended for mine hoisting and hauling, steam shovels, mining machines, etc. HERCULES Wire Rope always has one **red** strand for identification purposes. It is made in Round and Patent Flattened Strand constructions.

Special Steel

A grade of rope of but moderate cost, but possessing high efficiency in a wide variety of operating conditions. Its flexibility is equal to lower strength ropes (an uncommon property), consequently it is well suited for work over small drums and sheaves. Its advantages in point of strength, toughness, durability, and general trustworthiness, are exceptional.

Plough Steel

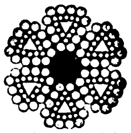
The tensile strength developed in Plough Steel Wire Rope is high, and this rope is successfully used where heavy work is performed under conditions where sufficiently large drums and sheaves are practicable.

Cast Steel

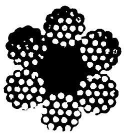
Cast Steel Wire Rope is standard for ordinary work, being of moderately high tensile strength and quite flexible. It works to good advantage over small sheaves and drums. Its use is general where there are no excessive stresses or unusual conditions encountered.

Wire Rope Construction

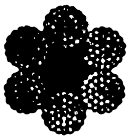
The numerous wire rope uses, each having its peculiar working conditions, require the manufacture of wire rope in a number of constructions.



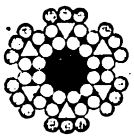
HOISTING
Patent
Flattened
Strand
(6 x 25)



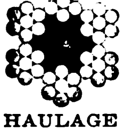
HOISTING
AND
MINING
MACHINES
Round Strand
(6 x 19)



HOISTING
AND
MINING
MACHINES
Round Strand
(6 x 37)



HAULAGE
Patent
Flattened
Strand
(6 x 8)



HAULAGE
Round Strand
(6 x 7)

Patent Flattened Strand

The greatest advantages afforded by the Patent Flattened Strand construction are: additional wearing surface, greater strength and flexibility, and resistance to crushing. For reasons simple and practicable it operates with economy under conditions where no other constructions of wire rope can work successfully. Especially recommended for mine hoisting and hauling, and for steam shovels.

Round Strand

Round Strand Wire Rope is composed of a number of wires twisted into a round strand, which are then laid around a hemp center. A rope is usually composed of six or eight strands, which are in turn made of seven, nineteen or thirty-seven wires each.

Dragon Brand Wire Rope

Dragon Brand Wire Rope is especially recommended for conveying machinery. It is a Patent Flattened Strand construction having the wires in every other strand laid in different directions, which eliminates twisting and rotating. The keystone shape of the strands prevents them from straightening out, thereby making it nonstretching.

Lay of Wire Rope

We can furnish wire rope in right lay, left lay, regular lay or Lang's lay. Tell us how your rope is to work and we will recommend the best lay to be used.

Aerial Wire Rope Tramways

Leschen Aerial Tramways provide efficient and economical means of transporting material of every description. Special system for disposing of waste materials. Full information upon request.

Wire Rope Lubricant

If best results are to be obtained from wire rope, its proper lubrication is essential. We furnish correct lubricant for every class of wire rope service. Write for catalog.

Engineering Department

An important factor in wire rope economy is the correct selection of rope construction. We have a large Engineering Department which has made careful study of mining conditions, and we shall gladly help you solve your wire rope problems.

MACOMBER & WHYTE ROPE CO.

MONARCH WIRE ROPE
"ALWAYS ONE WHYTE STRAND."
TRADE MARK REGISTERED.

Main Office and Works:
KENOSHA, WIS.
BRANCH OFFICES
Chicago, Portland, Pittsburgh,

Manufacturers of
Wire Rope of Every Description
Sole Makers
PATENT "KILINDO" NON-ROTATING WIRE ROPE
"MACWHYTE" WIRE ROPE
MONARCH WHYTE STRAND WIRE ROPE

KILINDO WIRE ROPE
"ROPE THAT'S RIGHT" MACOMBER & WHYTE.
POSITIVELY NON-ROTATING
TRADE MARK REGISTERED.

Products

Wire Rope, Sockets, Hooks, Thimbles, Wire Rope Clips, Turnbuckles, Sheaves, Blocks, "Monarch" Mine Car Hitchings, Manila Rope, Tramways.

Monarch "Whyte" Strand Wire Rope.

This is the highest grade rope manufactured. It is made from wire having a tensile strength of 125 tons to the square inch. It is uniform and dependable. The wire before entering the rope is subjected to stringent tests and unless our high standards have been complied with, the wire is rejected. In the manufacture of this rope great care is exercised. The lay of the wires in the strands as well as the strands themselves are perfectly proportioned so as to give each wire an equal portion of the working load. The core is number one hard laid Manila rope, which prevents the rope from pulling in and distorting its lays when subjected to severe strains. This rope is made in various constructions to suit working conditions. It is an absolutely safe rope, incomparable in wearing quality to any other cable on the market and is strong, durable and tough.

Patent Kilindo Non-Rotating Wire Rope

This rope is manufactured by us under a patent issued to George S. Whyte. It is being imitated by several concerns who will probably be lead to see the error of their ways before very long. Kilindo Non-Rotating Rope is exactly what its name implies. It does not rotate or spin when hoisting a loose load. It is, therfore, especially adapted for shaft sinking purposes, and it is also especially desirable to use this rope wherever a non-spinning rope is needed.

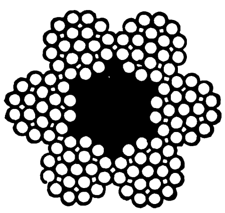
The word "Kilindo" is a combination of Greek words meaning "almost round." This brand of rope has a much larger wearing surface than the ordinary six strand rope.—About 200%.

We manufacture Kilindo in all grades such as "Monarch" steel, Plough steel, "MacWhyte" steel, Mild Plough steel, Crucible steel and Swedes iron.

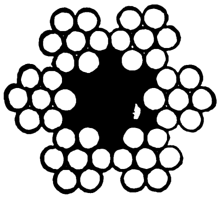
"Macwhyte" Wire Rope

A rope of superior merit, built for mining service where conditions are difficult. Made in various constructions to suit conditions.

This illustration shows our Standard Hoisting Wire Rope, which is composed of six strands of nineteen wires each, laid around a hemp center, making a total of 114 wires. It is the most common rope used for hoisting purposes and is manufactured in all grades of iron and steel, and where sheaves are built to accomodate it, it is the most practical rope to use.

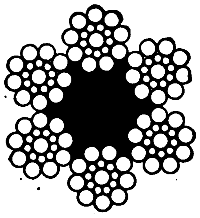


This illustration shows the construction of a wire rope usually termed haulage, transmission or standing wire rope. It is composed of six strands of seven wires each, laid around a hemp center, this making a total of 42 wires. It is constructed in various grades of iron and steel, which grades are suited to different working conditions. These ropes should never be operated over small drums or sheaves, the wires being too coarse.



Seale Patent Wire Rope

This is a rope composed of six strands of nineteen wires each laid around a hemp core. Each strand is composed of nine large outer wires, nine small inner wires and one large center wire, as shown in the adjoining cut. By this method of construction a rope is produced which is almost as flexible as a standard nineteen-wire rope, in which all the wires in each strand are the same size, but of greater durability in any service where the rope is exposed to unusual abrasion.

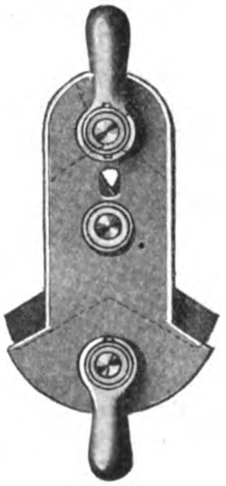


Safety Detaching Hook

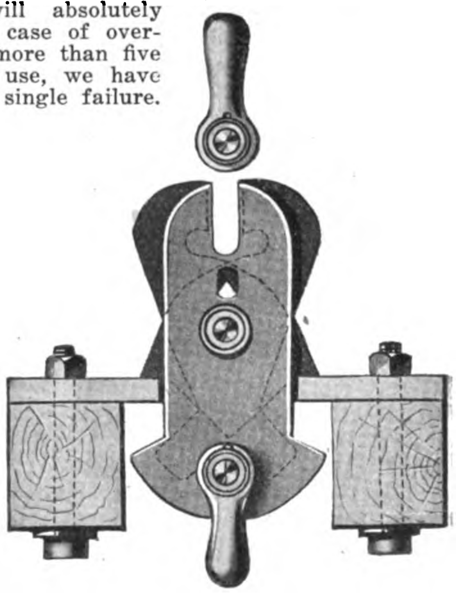
For the prevention of accidents by the over-winding at Mine Shafts

These are complete, simple, reliable, durable and safe. They prevent loss of life, save money and time.

This hook, will absolutely save the cage in case of over-winding, and on more than five thousand now in use, we have never heard of a single failure.



Working Order.



Detached and Suspended.

GEORGE C. MOON COMPANY, INC.

GARWOOD, N. J.

New York,
124 White Street.

San Francisco,
149 California Street.

Cleveland,
872 Rockefeller Bldg.

Seattle,
Terry Ave., North and Mercer Sts.

Manufacturers of

Wire Rope for All Purposes

Products

Iron and Steel Wire Ropes of all constructions and grades and Marline Covered Wire Ropes.

The following lists and cuts describe the standard constructions of ropes generally used in the mining field. Our general catalog which will be furnished on request contains full data on all other constructions and grades of rope which we make.

Cresent Haulage Rope

6 strands—7 wires to the strand—1 hemp core.

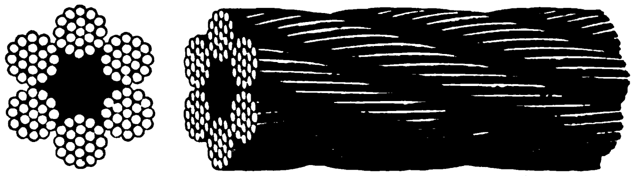
List Price Per Foot	Diameter in Inches	Circumference in Inches	Approximate Weight Per Foot in Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds
Cast Steel.					
.36	1⅛	3½	2	37	7.4
.29	1	3	1.58	31	6.2
.22½	⅞	2¾	1.20	24	4.8
.17	¾	2¼	.89	18.6	3.7
.14½	11/16	2⅛	.75	15.4	3.1
.13	⅝	2	.62	13	2.6
.10	9/16	1¾	.50	10	2
.08	½	1½	.39	7.7	1.5
Mild Plow Steel.					
.44	1⅛	3½	2	43	8.6
.35	1	3	1.58	35	7
.27	⅞	2¾	1.20	28	5.6
.20	¾	2¼	.89	21	4.2
.17	11/16	2⅛	.75	16.7	3.3
.14½	⅝	2	.62	14.5	2.9
.12	9/16	1¾	.50	11	2.2
.09½	½	1½	.39	8.85	1.8
Plow Steel					
.51	1⅛	3½	2	47	9.4
.41	1	3	1.58	38	7.6
.32	⅞	2¾	1.20	31	6.2
.24½	¾	2¼	.89	23	4.6
.21	11/16	2⅛	.75	18	3.6
.17½	⅝	2	.62	16	3.2
.14½	9/16	1¾	.50	12	2.4
.11½	½	1½	.39	10	2
Improved Plow Steel.					
.58	1⅛	3½	2	52	10
.48	1	3	1.58	42	8.4
.37	⅞	2¾	1.20	33	6.6
.28½	¾	2¼	.89	25	5
.24½	11/16	2⅛	.75	20	4
.20½	⅝	2	.62	17½	3.5
.17	9/16	1¾	.50	13	2.6
13½	½	1½	.39	11	2.2

Quality

The quality of the wire of which our ropes are made is of the very highest obtainable and is thoroughly tested by us before being made into rope.

Crescent Hoisting Rope

6 strands—19 wires to the strand—1 hemp core.



List Price Per Foot	Diameter in Inches	Circumference in Inches	Approximate Weight Per Foot in Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Diameter of Drum or Sheave in Feet Advised
Cast Steel.						
1.16	2	6¼	6.30	106	21.2	8
1.02	1⅞	5¾	5.55	96	19	8
.90	1¾	5½	4.85	85	17	7
.77	1⅝	5	4.15	72	14.4	6.5
.66	1½	4¾	3.55	64	12.8	6
.56	1⅜	4¼	3	56	11.2	5.5
.46	1¼	4	2.45	47	9.4	5
.38	1⅛	3½	2	38	7.6	4.5
.31	1	3	1.58	30	6	4
.24	⅞	2¾	1.20	23	4.6	3.5
.19	¾	2¼	.89	17.5	3.5	3
.14	⅝	2	.62	12.5	2.5	2.5
.12	9/16	1¾	.50	10	2	2.25
.11	½	1½	.39	8.4	1.68	2
Mild Plow Steel.						
1.34	2	6¼	6.8	123	24.6	8
1.25	1⅞	5¾	5.55	112	22.4	8
1.10	1¾	5½	4.85	99	19.8	7
.94	1⅝	5	4.15	83	16.6	6.5
.80	1½	4¾	3.55	73	14.6	6
.68	1⅜	4¼	3	64	12.8	5.5
.56	1¼	4	2.45	53	10.6	5
.46	1⅛	3½	2	43	8.6	4.5
.37	1	3	1.58	34	6.80	4
.29	⅞	2¾	1.20	26	5.20	3.5
.22	¾	2¼	.89	20.2	4.04	3
.16½	⅝	2	.62	14	2.80	2.5
.14	9/16	1¾	.50	11.2	2.24	2.25
.12½	½	1½	.39	9.2	1.84	2
Plow Steel						
1.58	2	6¼	6.8	140	28	8
1.46	1⅞	5¾	5.55	127	25	8
1.30	1¾	5½	4.85	112	22	7
1.08	1⅝	5	4.15	94	19	6.5
.93	1½	4¾	3.55	82	16	6
79	1⅜	4¼	3	72	14	5.5
.65	1¼	4	2.45	58	12	5
.54	1⅛	3½	2	47	9.4	4.5
.43	1	3	1.58	38	7.6	4
.34	⅞	2¾	1.20	29	5.8	3.5
.26	¾	2¼	.89	23	4.6	3
.19	⅝	2	.62	15.5	3.1	2.5
.16	9/16	1¾	.50	12.3	2.4	2.25
.14	½	1½	.39	10	2	2
Improved Plow Steel.						
1.85	2	6¼	6.30	166	33	8
1.75	1⅞	5¾	5.55	150	30	8
1.60	1¾	5½	4.85	133	27	7
1.30	1⅝	5	4.15	110	22	6½
1.10	1½	4¾	3.55	98	20	6
.90	1⅜	4¼	3	84	17	5½
.75	1¼	4	2.45	69	14	5
.62	1⅛	3½	2	56	11	4½
.50	1	3	1.58	45	9	4
.39	⅞	2¾	1.20	35	7	3½
.31	¾	2¼	.89	26.8	5.3	3
.23½	⅝	2	.62	19	3.8	2½
.19	9/16	1¾	.50	14.5	2.9	2¼
.17	½	1½	.39	12.1	2.4	2

Guarantee

We guarantee our product to be at least equal to any other on the market and will furnish, when requested to do so by the customer, certificate of test.

JOHN A. ROEBLING'S SONS CO.

TRENTON, N. J.

CHICAGO, PHILADELPHIA, PITTSBURGH, CLEVELAND, ATLANTA.
John A. Roebling's Sons Co., of New York, New York.
John A. Roebling's Sons Co., of California.
SAN FRANCISCO, LOS ANGELES, SEATTLE, PORTLAND, ORE.

MANUFACTURERS OF

WIRE ROPE

General

The first wire rope used in this country was a Roebling rope. Since its production the manufacture of wire rope has never been interrupted, and as the demand has increased the facilities for production and distribution have expanded so that the Roebling Company now has three works (two at Trenton, N. J., and one at Roebling, N. J.) and has also numerous branches in different parts of the country.

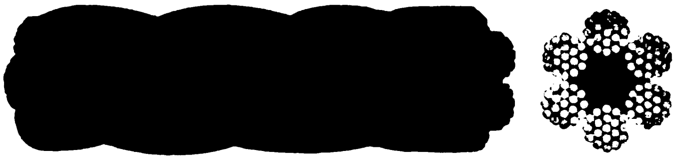
Stocks are kept at warehouses in connection with the branches and these can be drawn on for prompt shipments.

For detailed information apply to any address named above.

Products

Over 400 different sizes and constructions of wire rope are made at the Roebling works. Wire Rope Fittings such as hooks, sockets, etc., are also made and kept in stock for prompt deliveries.

None but carefully selected and thoroughly tested metals are used for Roebling rope. There are several grades of these metals. Those most commonly used are briefly described below.



Rope with 6 Strands of 19 Wires each and a Hemp Center.

Blue Center Steel Rope

Recent advances in the manufacture of steel have made possible the production of a grade particularly well adapted for rope wire, and excelling all others in strength and toughness.

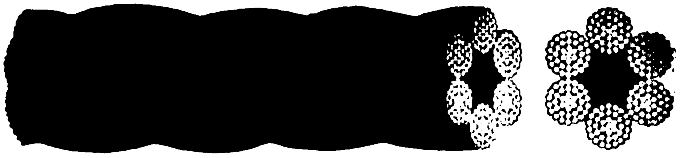
Where conditions are such that the maximum of strength for a given diameter of rope must be obtained, or severe abrasive tendencies exist, blue center steel should be specified.

Blue center steel rope is not only well adapted for ropes of unusual size, but it will give the maximum service in the ordinary diameters. The hemp center of Blue Center Steel Rope, in constructions where a hemp center is used, is colored blue to distinguish it from other grades.

Plow Steel

Up to the time of the production of blue center steel, the strongest and toughest rope was made of plow steel.

Plow Steel comes next in strength to blue center steel and may be used in place of the latter if the maximum strength for the diameter is not essential or if it is not considered necessary to take advantage of the extra power of resistance to abrasion of blue center steel.



Rope with 6 Strands of 37 Wires each and a Hemp Center.

Extra Strong Cast Steel

Extra Strong Cast Steel Rope occupies an intermediate place between cast steel and plow steel. It can be used to advantage in place of cast steel under conditions suitable for the latter, when it is desired to increase the safety of a rope of given diameter.

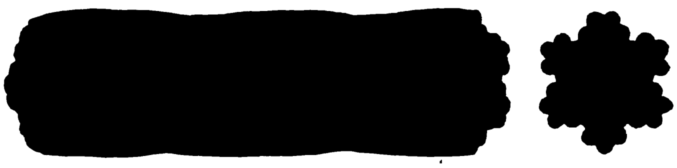
Cast Steel

Rope made of cast steel is used largely for mine hoists and haulages, and on coal hoists, cableways and conveyors. While cast steel does not have the strength per square inch of the other steels referred to above and lacks the resistance to abrasion of plow or blue center steel, conditions often exist where for a given diameter of rope the stress is not beyond the working strength of cast steel and its wearing qualities are amply sufficient.

In contemplating the selection of a wire rope, if doubt exists as to the grade, we shall be glad to make suggestions on being advised of conditions.

Iron

Iron Rope is used mostly for the operation of the drum type of passenger elevators. It is the best rope for that purpose, but being softer it lacks the strength of steel rope and will not resist abrasion as well. Iron Rope therefore is not economical to use under conditions generally encountered in mining.



Rope with 6 Strands of 7 Wires each and a Hemp Center.

Standard Constructions

The standard construction for hoisting rope is six strands of 19 wires each and a hemp center; for haulage rope, six strands of 7 wires each and a hemp center.

To obtain greater pliability in hoisting rope it is sometimes made of six strands of 37 wires each, or eight strands of 19 wires each.

WATERBURY COMPANY

63 PARK ROW

NEW YORK CITY

MANUFACTURERS OF

Wire and Fibre Rope for Operation of Mines and all General Uses

FACTORY—Brooklyn, N. Y.

BRANCHES

1315-1321 W. Congress St., Chicago, Ill.
151-161 Main St., San Francisco, Cal.
A. T. Powell & Co., Dallas, Texas
1018 Maison Blanche Bldg., Canal and Dauphin Sts., New Orleans, La.

Products

Wire Rope, Manila and Sisal Rope, Non-Rotating or Non-Spinning Rope, Marline Covered Wire Rope, known as Fibreclad; Waterbury Armored Rope (Gore Patent March 14, 1911).

Waterbury Wire Rope

Is made in grades known as Swedish Iron, Crucible Cast Steel, Extra Strong Cast Steel, Plow Steel and Green Strand Giant Steel, the latter being the highest grade of Improved Plow Steel.

Mining Ropes

The importance of best quality ropes cannot be overestimated owing to the severity of work and danger to life. The size of rope or class of material depends largely on the character of operation, such as hoisting or haulage. Our Engineering Department will gladly render assistance in determining questions as to the most suitable rope for use, in case of incline planes, subdivided into gravity and self-acting systems, engine or power planes, tail ropes or endless rope systems.

Waterbury Armored Wire Rope (Gore Patent Mar. 14, 1911)

Is made 6 strands, 19 wires to the strand, 37 wires to the strand or 61 wires to the strand, according to size and conditions of use. It is furnished in Crucible Cast Steel, Extra Strong Cast Steel, Plow Steel or Giant Improved Plow Steel stock.

The strands in this class of rope are wound or served with flat wires having convex edges, which wires take the abrasion on crown of strands. The initial factor of safety is maintained longer in Waterbury Armored Rope than in any other class of rope. It is most suitable for mining purposes, and particularly so for haulage operations. Waterbury Armored Rope has the advantage over rope of ordinary construction inasmuch as wear on crown strands does not commence until the serving has worn down, and after that period such wire serving becomes packed into the interstices of rope, making it cylindrical and thus materially increasing the efficiency of the rope. A cylindrical rope is less subject to wear on crown strands than rope of ordinary construction.

Fibreclad Marline Covered Wire Rope

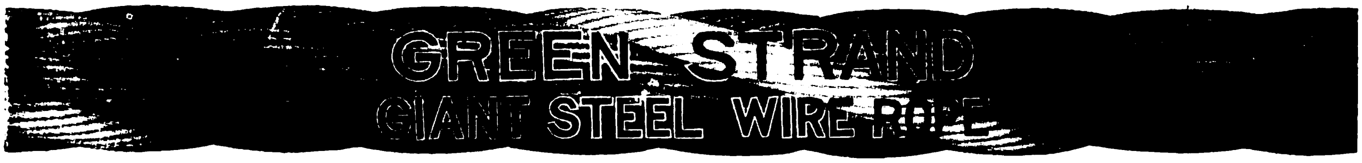
A combination rope of wire and the best grade of Tarred Russian Hemp Marline. It replaces Manila or Wire Rope for transmitting power at coal washers, coal breakers or wherever Wire or Manila Rope is used for power transmission purposes. The Tarred Marline affords protection against acid water and moisture, foreign matter, such as coal dust and residue, always prevalent where rope drives are in use. It is not affected by atmospheric conditions, as in the case of Manila Rope or Wire Rope. It is about one-third the diameter of Manila Rope of the same strength. Is flexible and will coil down as readily as Manila Rope. Will outwear bare wire rope under most all ordinary working conditions, likewise Manila Ropes, consequently is more satisfactory in the end. Is also used largely for hoisting and other purposes.

Manila and Sisal Rope (for General Use)

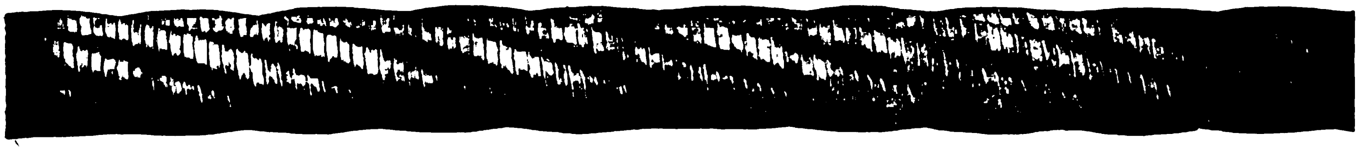
Manila Transmission Rope

We make a special rope for power transmission purposes, made from the best selected Cebu Manila Hemp. Transmission Ropes are made 4 strands with heart, unless otherwise ordered. The yarns are treated with a special composition, which thoroughly lubricates the strands and individual fibres, making the rope as near waterproof as possible. Our Transmission Rope is especially adapted for rope driving and made as nearly perfect as the best machinery, superior quality of material and wormanship can produce.

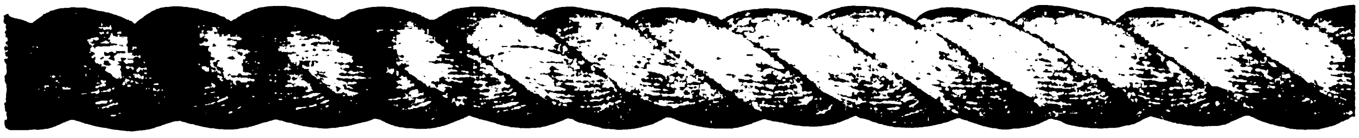
Ask for prices, samples or other particulars.



Waterbury "Green Strand" Giant Steel Wire Rope. Write for Wire Rope Catalog.



Waterbury Armored Rope (Gore Patent). Write for Armored Rope Catalog.



Waterbury Fibre Rope—Manila and Sisal. Write for Fibre Rope Catalog.

Waterbury Fibreclad Wire Rope. Write for Fibreclad Wire Rope Catalog.

WRIGHT WIRE COMPANY

Worcester, Mass.

Manufacturers of

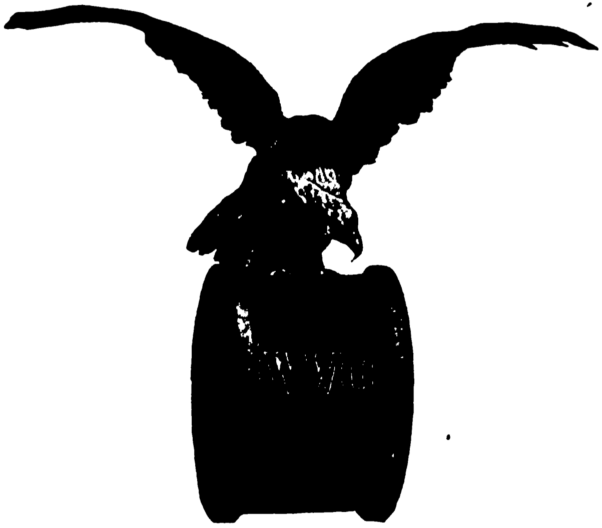
Wire, Wire Rope and Wire Products

Branch Offices:

Boston .... 256 Franklin St.
New York .... 256 Broadway.
Philadelphia .... 410 Commerce St.
Chicago .... 33 West Austin Ave.
San Francisco .... 111 Townsend St.

Products

Wire Rope; Wire Fencing; Wire Cloth; Wire Lathing; Iron and Steel Wire; Staples; Poultry Netting; Screen Cloth; Ornamental Iron Work of Iron, Brass, or Bronze, such as Elevator Cabs, Gratings, Railings, Window Guards, Gates, Bank and Office Fixtures. Also all kinds of Grille Work; Wire Partitions; Stock and Tool Room Enclosures; Machinery Guards; Stable Fittings; Clothes Lines; Picture Cord; Coal and Sand Screens, and Foundry Riddles.



EXCELSIOR

Excelsior Wire Ropes are made from specially selected materials in a wide variety of types to meet every engineering need.

Materials

We furnish rope of iron, crucible cast steel, extra strong crucible cast steel, plow steel, and Excelsior plow steel.

The wire is drawn in our own mills under rigid supervision and the greatest care is used in the making of the rope.

Construction

The standard construction for hoisting rope is 6 strands of 19 wires each laid about a center core of hemp. Where extra flexibility is desired 6 strands of 37 wires each may be employed.

Haulage rope has usually 6 strands of 7 wires each about a hemp core. This core is thoroughly saturated with a special compound to lubricate the wires and prevent rust.

Uses

We supply ropes for hoisting, haulage, derricks, dredges, power transmission, cableways, tramways, suspension bridges, and all purposes where wire rope can be utilized to advantage.

Fittings

We furnish a full line of wire rope fittings, such as sockets—both open and closed—hooks, thimbles, turn buckles, clamps, etc.

How to Order Wire Rope

In ordering be sure to state:

1. The diameter of the rope required.
2. Its exact length.
3. The number of strands.
4. The number of wires per strand.
5. The purpose for which it is to be used.
6. The stock from which it is made.

If uncertain what rope is best suited to your needs, state fully the use to which it will be put, giving details of loads, speed, and size of drums or sheaves.

Standard Haulage Rope.
6 strands of 7 wires each around hemp core.

Standard Hoisting Rope.
6 strands of 19 wires each around hemp core.

Special Flexible Hoisting Rope.
6 strands of 37 wires each around hemp core.

THE TEXAS COMPANY

NEW YORK HOUSTON

Petroleum and Its Products

The Preservation of Wire Rope

In these days the preservation of wire rope is assuming greater importance than ever before.

A rope which was formerly considered as just so much steel, is now coming to be understood and regarded as the intricate machine which it actually is.

It may surprise the average rope user to learn that 100 feet of 1" wire rope shows a frictional surface which should—and CAN be lubricated, totaling 344 square feet. The true magnitude and the importance of this figure can be realized by comparison to the frictional surface on what is practically the largest engine in the United States.

This is a 35,000 H.P. engine of the Twin-Tandem Reversing Type, in use in a large steel mill and, incidently., lubricated with TEXACO LUBRICANTS. This engine has a total frictional area, including cylinder walls, valves, and all bearings of 319 square feet. In other words a mere 100 feet of wire rope has more surface to be lubricated than this huge engine. The wonder is that unlubricated or improperly lubricated wire ropes last as long as they do.

What We Have Accomplished

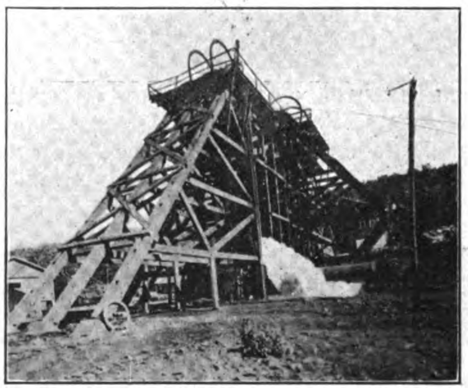
The engineers of The Texas Company have contributed much to the science of rope lubrication and preservation. Careful study and costly experiments extending over many years were required to reach our present status in this field.

Long ago we realized that we had a wire rope lubricant of unequalled efficiency, but we spent years of study in ascertaining the best methods of applying it before we marketed TEXACO CRATER COMPOUND. Now, we have encountered every known wire rope and gear condition in coal mine work, and can predicate the way in which TEXACO CRATER COMPOUND will meet each one.

What is Texaco Crater Compound ?

First. TEXACO CRATER COMPOUND is a straight heavy lubricant of unparalleled excellence for wire ropes. It contains no filler, such as rosin, tar, tallow, graphite, etc.

CRATER does what no other product on the market can. It COATS the rope, PENETRATES between the strands, saturates the core, and LUBRICATES. TEXACO CRATER COMPOUND clings to metal surfaces. It cannot be shaken from the rope by vibration or shock. It will not run, throw off, or drip. It is impervious to mine acids, weather, or water. It resists heat as well as cold. It does not harden, crack, nor flake, and it remains a lubricant at all times.



Water Hoist of a Large Pennsylvania Mine. We ran a test on this water hoist. Rope laid up in and treated with "CRATER" hoisted 101,815 buckets. Two previous ropes hoisted 58,483 buckets, average. All ropes from the same rope maker.

Why Ropes Fail—How to Save Them

The lifting strain alone does not cause wire rope to fail—the main factors which do are corrosion and frictional wear—almost always internal. TEXACO CRATER COMPOUND saves the rope. It prevents corrosion, checks friction, stops wear. The next page explains fully.

How Texaco Crater Compound Saves Wire Ropes

How Crater Stops Wear

The fine coating of heavy lubricant given to every wire by "CRATER" means that wear due to the friction of drums and sheaves is stopped. But, what is more important is that internal wear is checked.

When the rope is laid up in CRATER, i. e., when the wires are coated in laying up and the hemp core is saturated with it, this core acts as a reservoir for the lubricant. Extra strains such as longitudinal stresses or the pressure caused by bending over or under the sheave wheel, or around the drum, serves to squeeze out a little of the lubricant and force it between the wire strands. Thus, the twisting and cutting action of the wires is performed on a film of CRATER and not upon each other. The wear is stopped. The rope lasts longer.

Furthermore, when a rope so treated is given frequent coatings, the outer as well as the inner strands will be continually lubricated, and a rope so treated will show a doubled length of life.

Prevents Corrosion

The saline or heavy sulphur and acid water met in mines attacks the metal. It is corroded and eaten away. The strands of the rope become thin and brittle, breakage occurs. Too often this is inside the rope and it is only discovered when the rope fails.

The outside may be whole and unworn, but the continuous contact with a moist tainted core often ruins the inner strands in a short time. If the core of that rope were saturated with CRATER, the acid water would have no effect upon it, and if the outside of the wire were coated with CRATER, the mine water would not have any effect upon them whatsoever.

That is why CRATER treated ropes last so much longer. A fine example of the resistance to corrosion afforded by CRATER was furnished by a performance on one of the water buckets of a large Pennsylvania coal mine. The acid water corroded the buckets, especially at the rivets. We coated the buckets with CRATER. Seven months later the coating was still intact. All this exposure to acid water, plus the dripping action in the sump, could not dislodge the protective acid-proof coating of TEXACO CRATER COMPOUND. Think how it will protect your wire rope.

When You Order New Rope Specify That It Be Laid Up in Texaco Crater Compound.

All the larger wire rope manufacturers will be glad to lay up your wire rope in TEXACO CRATER COMPOUND during the process of manufacture. It means that this rope is protected from the start. It means that you can readily apply the necessary light coatings to keep the rope in prime condition. It means that your wire rope will last longer, frequently more than twice as long. Specify TEXACO CRATER COMPOUND. It pays.

How To Apply

To secure proper results, the TEXACO CRATER COMPOUND is applied hot, and by means of a split box. This box serves as a container for the compound. An old rubber valve, or even a piece of burlap at the base of the box serves to hold the lubricant. The rope is run through the box slowly, and a clean light coating is secured. We will gladly furnish blueprints and descriptions of this simple and efficient contrivance for hoist or slope ropes.

Some Other Uses For "Crater"

As a gear dressing CRATER is without a rival. Its rich lubricating quality and its adhesiveness to metal surfaces mean that the teeth of gears are coated and lubricated. Wear and abrasion are stopped. Because water, acids, and the elements do not effect CRATER, operators are using it as a protection against corrosion on buckets and on iron and steel work around the mine. Because of its resistance to heat and gases, it has been used to preserve the INSIDE of iron smoke stacks.

And further proof of its high resistance to moisture and heat is shown by its use on the flanges and packings of steam lines, with eminent success.

TEXACO CRATER COMPOUND is shipped in wooden barrels about 400 lbs. each, half barrels, and 25-lb. cans. Write us fully for prices at your mine and for further particulars. Remember also, CRATER is but one of a long line of the quality petroleum products we make. Some of the others are:

TEXACO CYLINDER OILS
TEXACO MACHINE OILS
TEXACO MINE CAR LUBRICANTS
TEXACO MINERS WAX
TEXACO BURNING OILS
TEXACO NAPHTHAS
TEXACO ROOFING, and many others.

Write for the free 48-page book "Wire Rope Lubrication." It tells all you want to know about the lubrication and preservation of wire rope in a simple but scientific way.

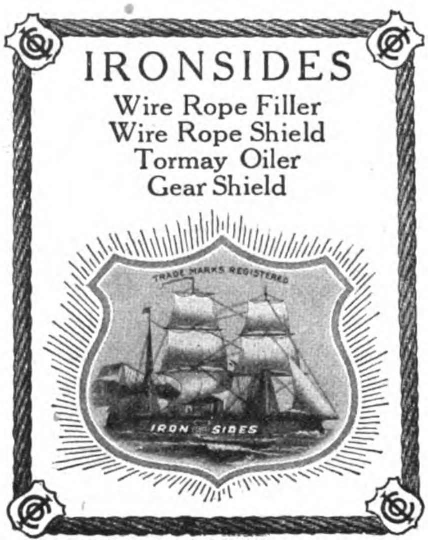
We will thank you to address all inquiries to us at Department K., 17 Battery Place, New York City

THE IRONSIDES COMPANY

Office
Hartman Building, Columbus, Ohio, U. S. A.

Manufacturers of

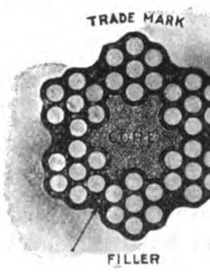
Special Lubricants and Preservatives



Ironsides Wire Rope Filler

Ironsides Wire Rope Filler is a lubricant for internally treating ropes as laid up by the manufacturer. Rope for all purposes; Cable Railways, Hoists, Inclined Planes, Power Transmission, Elevators, etc., are lubricated and preserved. It lubricates between the strands and seals the gutters, making watersoaked and corroded interiors impossible. The lubricant as well as surrounding the core and strands, penetrates the core which serves as a reservoir, releasing small quantities of the preservative to the rope as needed.

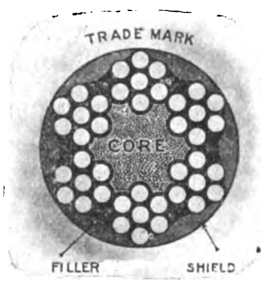
Ironsides Wire Rope Filler contains no destructive acid. By its use the core is lubricated and preserved, wires adjoining the core are lubricated and preserved from corrosion, abutting wires between strands are lubricated, each strand is cushioned in lubrication. Ropes so treated are pliable, readily accommodating bends, and show less of the evil effects of frequent bending.



Our Ironsides Wire Rope Filler is used by many of the best wire rope manufacturers. Purchasers by so specifying may have their ropes laid up in this material.

Ironsides Wire Rope Shield

Ironsides Wire Rope Shield is a pliable, tenaceous and water-proof lubricant for outside application to ropes. It is extensively used throughout all mining and industrial districts for lubricating ropes through external application. In contains no destructive acid, lubricates between the wires, lubricates and protects the high points of the strands. It is an acid-proof and waterproof lubricant, making corroded or watersoaked interiors impossible. It is so tenaceous that it is not shaken from the rope by hoisting with the modern high speed hoists, and is so elastic that it bends with the wire and lubricates and preserves the sheaves as well as the rope.

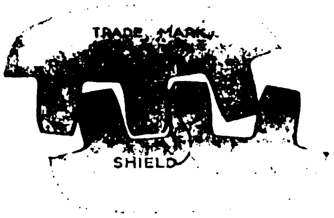


Ironsides Gear Shield

Ironsides Gear Shield is a tenaceous, water-proof lubricating compound for all classes of gearing: It is the only lubricant that through occasional reapplication, maintains lubricated working faces on gear teeth.

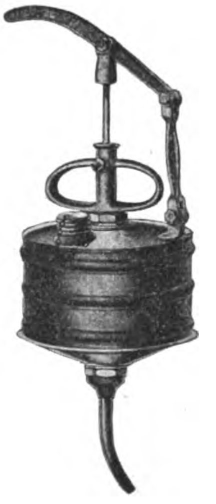
This lubricant on gear teeth prevents metallic contact, lessens the noise through lubricated contact, diminishes noise by lubricated backlash, greatly retards wear on all new gearing, arrests excessive wear on worn gearing and reduces the expense of frequent replacements.

For electric mine motor gears and pinions, and mining machine gearing, our specially recommended grade can be used in accumulated form in cases. Where heavier bodied grades are used, apply by pouring the lubricant over the slowly revolving gears. This avoids waste, and accumulation as well, in the bottom where gears are encased.



Ironsides Improved Tormay Oiler

The Ironsides Improved Tormay Oiler consists of a central working barrel, containing a plunger, and surrounded by an oil reservoir. The openings in the working barrel, sealed or unsealed, according to the position of the plunger, communicate with the oil reservoir. The stroke of the plunger being adjustable, governs the quantity of oil forced by each operation. When not in use oiler may be placed in any position without leakage of contents, but should be hung up by the handle on a hook for its protection.



Primarily constructed for the oiling of Mine Car Wheels, its use has spread widely until it is now being used about General Machinery, Locomotives, Stationary Engines, Motors, Hoisting Drums, Sheaves, Guides, Slope rollers, and in fact, all places where ordinary oil cans are applicable.

Built in four sizes as follows: ½, ¾, 1, and 1½ gallon.

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

TRACK SECTION

Treatise
and
Engineering Data

Specifications and Dimensions of Light Steel Rails.

Rail Data.

Curvature of Track—Table.
Frog and Switch Data.

The following manufacturers and dealers have catalogue descriptions in this section:

Buckeye Rolling Mill Co.
Cincinnati Frog & Switch Co.
Clinton Switch Co.
Contractors Mach. & Supply Co.
Elliot Frog & Switch Co.
Fairmont Mining Machinery Co.
Foster, L. B., Co.
Frank, M. K.
Green, L. A.,
Indianapolis Switch & Frog Co.
Kilby Frog & Switch Co.
Lazarus, M. E. Co., The.
Light Railway Equipment Co.
Richardson & Co., The.
Sweet's Steel Co.
United States Rail Co.
Weir Frog Co.
West Virginia Rail Co.

For additional descriptions of Track Equipment, not appearing in this section, refer to Index of Products in front of book.

MINE TRACKS

By E. N. Zern, E. M.*

Economical transportation of coal from the place where it is mined to the surface where it is loaded for shipment is a requirement for the successful operation of a coal mine.

To insure the highest economy there are needed: (1) favorable grades, (2) good trackage, (3) side tracks, partings, etc., to provide for the passing of trips and the assembling of loaded and empty wagons, (4) a sufficient supply of mine cars properly designed to meet the mining requirements and well maintained, (5) ample mechanical equipment selected for its suitability to operating conditions, and (6) a carefully planned and supervised system of operation.

All but the first mentioned of these are attainable by good management plus an understanding of the conditions likely to be encountered, and even here much may be done to better the prevailing conditions.

The road bed is the starting point in the endeavor for good haulage. Granted a properly drained bottom; a rail of sufficient size, well connected and laid on ties ample in size and correctly spaced; good alinement; an appreciation of the value of ballasting; and the necessary attention to maintenance—the foundation is then well laid for an economical system of transportation.

Historical

Throughout the early days of the industry in England and Scotland coal was carried from the working places in sacks or baskets suspended on the back. Wheel-barrows and carts were used in many instances and are still found in ore mines where the haul is short.† These were run on the floor causing considerable jolting where the bottom was uneven. Planks laid longitudinally with the heading were then tried and the barrow run on these. The chief difficulty lay in the tendency of the planks to curl up at their ends. "A great improvement in the working of collieries was introduced or extended about this time, (1676), namely, the tram-plate. Planks had been in use for a long time, for they are described by Sir Frances North (Lord Guildford) in 1676, and on these, bulky carts on rollers, containing 4 to 5 chaldrons, or about 12 tons, were drawn along to the staiths (landings) by one horse. These wagon-ways were greatly improved in 1765 by the introduction of cross-sleepers to tie the planks, and about the same time (1767) the Coalbrookdale Company, having an abundant stock of iron on hand during a period of trade depression, laid down cast-iron slabs on a tramway as a temporary experiment, but found so great an improvement in the transport, that the slabs were never taken up, and this is the prototype of the railways of our time. The iron tram was soon in general use at collieries above and below ground, and remained so until the introduction of the rail."‡

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*Head of Mining Department, West Virginia University.

†For a more detailed historical account see "The Evolution of Mine Haulage," Mines and Minerals, Vol. 30, pg. 683.

‡From "Coal Pits and Pitmen" by Boyd.

RAILS

The cast-iron tram-plates, introduced in the eighteenth century, were succeeded by wrought-iron rails, and these, in turn, gave way to rails made of steel. The weights of steel rails manufactured for mine service are 10, 12, 16, 20, 25, 30, 35, 40, 45, 50, 55 and 60 pounds per yard. Most of the lighter weights and all of the heavier conform in section to A. S. C. E. standards. Heavier rails than the last named are used in a few mines.

In the selection of rails, it is false economy to skimp on the original cost too much. A road constructed of too light a section of rail, while showing a saving in first cost, will require the expenditure of the saving over and over again in repairs and maintenance, to say nothing of the loss in delays to traffic. Each year as it passes removes the workings farther away from the mine opening and requires a longer haul. To maintain the output it is necessary that there be more cars to each trip and more speed in transit. This, in turn, obliges the use of heavier motor equipment and to bear this increased traffiic, a heavy rail and good roadbed are necessities and should be provided at the beginning of the enterprise.

Since the weight of rail depends largely on the type of haulage equipment, it follows that the smaller sizes are found in thin seams where haulage is done by animal power, while the larger sections abound in the thick seams using large wagons and heavy motor equipment. As illustrating the former may be mentioned several mines in Illinois using 10 and 12 pound rails on secondary haulages. The Vesta mines at California, Pa., mining the Pittsburg seam, as an example of the other extreme, uses 80 pound rail on their main haulages.

For average conditions the following minimum sizes of rail are recommended for general mine service:§

Weight of Locomotive.	Weight of Rail.
4 ton to 6 ton	16 lbs. per yard.
6 ton to 8 ton	20 lbs. per yard.
8 ton to 10 ton	25 lbs. per yard.
10 ton to 13 ton	30 lbs. per yard.
13 ton to 15 ton	40 lbs. per yard.
15 ton to 20 ton	50 lbs. per yard.

In general it may be said that in the thicker seams using mechanical haulage, a popular selection is 40 to 60 pound rail for main haulages; 20 to 40 pound for the cross entries, and 16 to 25 pound for the rooms. For the purpose of insuring the easy movement of cars to and from the cages, tracks at the shaft bottom are frequently provided with a heavier section than used on the main haulages.

Standard angle-bars are used for connecting the heavier rails, while for the lighter rail sections and in the rooms, fish-plates are common. The practice of depending upon spikes at the rail ends to hold them in contact is to be condemned as in time these work loose, causing derailments and the consequent loss of time.

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§From the Baldwin-Westinghouse Catalog.

Steel Rails

Steel rails may be said to be of two kinds, first, those rolled from the original billet or new seconds and sold as billet rails; second, those rolled from used rails and sold as re-rolled rails. A description of the process of manufacture of the former does not belong here. Re-rolled rails have an extended use in mines. These are made from old rails discarded by the railroads because of wear, or sometimes because a heavier section is needed for increased traffic. These rails are purchased by mills specializing in the manufacture of the lighter sections. The process in these mills is similar to that where rails are rolled from the billet, the difference being in the starting point, a used rail in one case and a billet in the case of a new rail.

After a rigid inspection has been made for flaws, the rails are broken into such lengths as will roll into the specified lengths of light rail sections. They are then charged into a furnace where they become heated to a rolling temperature. The heated rail is then brought to the rolling mill and receives the necessary number of passes, usually seven to nine, making it longer in length and smaller in section at each operation until the desired section is reached. After the rail has gone through the finishing pass, it is hot sawed to the specified length, cooled, straightened, and punched for the splice bars.

In the process of heating, or annealing, and rolling, the strength of the old rail, which may have become impaired owing to crystallization, is restored.

Wood Rails

A few years ago wooden rails for the rooms were in general use and they are still found in the smaller operations where timber is cheap. Oak is the common wood. In section they are 3" x 5", the larger dimension being placed uppermost. In length they vary from 10 to 18 feet. The continuous length of rails make butt joint connections and are held in place by spiking to a cross tie. The objection to wood rails lies in that it does not provide a strong or secure track. The rails are frequently warped and twisted before laying and in time the insecure method of fastening and lack of attention invite the derailment of cars. In addition they do not provide a return where gathering is done by electric locomotives.

Gage

The gage of a track is understood to mean the distance between the inside edges of the heads of rails, as shown in Fig. 1. One-half inch play for wheels and axles is the usual allowance on straight track.

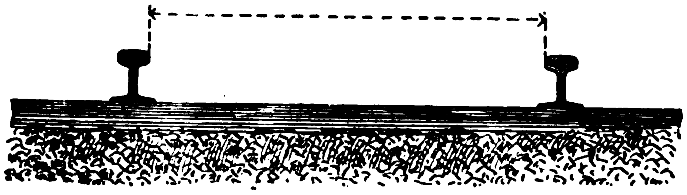

Fig. 1. Gage of Track.

In no branch of the coal industry is the lack of standardization more noticeable than in the department of haulage, and nothing can illustrate this more clearly than a view of the various gages used in coal mines. Some of these are as follows: 22, 24, 26, 26½, 28, 29, 29½, 30, 32, 33, 36, 37, 38, 39, 40, 42, 44, 48, and 56½ inches, the last mentioned being standard railroad gage and used in several West Virginia mines. The commonest gauge in low seams is about 36 inches, while that of the higher seams is about 42 inches.

It would be difficult to explain, and much more so to justify, this wide variation in track gages. Frequently in the same seam, and under the same working conditions, a dozen different gages are found. Thus, in the Pittsburg seam, remarkable for its uniformity, gages vary from 30 inches to 48 inches. In the various Illinois mining districts this tendency is even more noticeable. It appears that insufficient thought has been given the matter and little serious effort made to determine which gage is the best suited to the purpose of economical production.

It is well, therefore, to consider briefly what factors determine track gage. The foremost of these is the local condition. The thickness of the seam determines the height of entry. The conditions of roof and bottom determines entry width. The factors which limit the height and width of entry, in turn, exercise a like influence on the corresponding dimensions of the mine car. If both of these are restricting, we may, theoretically, attain capacity for the car by increasing its length, but here again we are confronted, in practice, by the necessity of a short wheel base, so that the length of the car, measured inside, seldom exceeds 10 to 11 feet. Of the three restraining influences mentioned that of width of entry is the one most susceptible of regulation. Mine cars vary in breadth and gages vary in width correspondingly.

It will be obvious from an understanding of mining conditions that no standard gage can be adopted for all mines, operating as they are in various seams and under varying conditions, but it is equally true that no justification can be found for the two score variety of gages found in our coal mines. Since the result of this multiplicity is that the manufacturers of track and haulage equipment are obliged to keep in stock patterns and repair parts in large numbers, with the coal industry bearing the extra charges involved, it is in the interest of economy that gages be limited to a smaller range, such as 24, 30, 36, 42 and 48 inches. These will be found ample to cover every contingency which may be expected to arise. In addition to a direct saving effected on the purchase of equipment and supplies, the sale of second-hand equipment would be greatly facilitated.

Broad gages give a greater stability to the cars and promote smoother operation of equipment with less of wear and tear on track and rolling stock. Narrow gages permit an easier movement on sharp curves but are prone to make the cars top heavy. Since broad gages require longer ties they are more expensive to construct. Especially is this true where grading of the road bed is necessary.

Alinement

The alinement of roads in modern mines is evidence of the presence of the engineer. Frequently, in the past, entry driving was allotted to the favored few who might be expected to keep a straight course, whether by sighting along the rail, by the cleat of the coal, or by a developed sense of direction. Not a few succeeded in doing creditable work, but in the majority of cases a meandering heading resulted. A satisfactory haulage under such conditions proves impossible. All of the larger companies now project their workings throughout the entire property. The direction of entry driving is governed by sights, or points, placed reasonably close to the face, and it is expected that these be used frequently to check the course of entry. With such precautions entries are driven straight and a good track alinement naturally follows.

Ballasting

The material used for ballasting is generally the top rock overlying the coal. If the bottom be kept dry and the rock withstands decomposition due to the action of air or moisture a firm road bed is provided. Sometimes ashes from the boilers are brought into the mines and used for this purpose. Leveling of the track is done by means of a straight edge and spirit level.

MINE TIES

Wood ties are used on main roads, cross entries and in rooms. Chestnut, oak and hard pine are the woods most frequently met with though this depends largely upon the locality. Sassafras, elm and hickory are found in many Illinois mines. In the denuding of forests locust is sometimes cut along with the other woods, and one mine in West Virginia may boast of a goodly number of walnut ties on their main haulage roads.

The dimensions of the tie used will vary according to the importance of the trackage and the weight of rail, but in general it may be said that on main haulages, using from 40 lb. to 80 lb. rail, ties should have a 6 inch to 8 inch face, be 6 inches deep, and project from 8 to 15 inches on each side of the rail. The larger projections serve to stabilize the track and to save the tie from splitting when spikes are driven. Spacing of ties varies from 18 inches to 24 inches center to center.

On side entries, using, say 30 lb. rail, a 5″ x 5″ tie with 8 to 12 inches of side projection is often used, the spacing being 24 inches center to center. In rooms using a 20 lb. rail, a 4″ x 4″ tie with a projection of 8 inches answers, the spacing being 24 inches center to center.

Mine ties as usually supplied are hewn on two faces with the bark on the side. It is preferable that the bark be removed since it serves to hold moisture against the tie. A sawed tie is not as good as a hewn tie. The cut of the saw leaves a more or less wooly surface which permits the retaining of moisture and encourages fungus growth.

Steel ties are coming into extended use for room and entry haulage and have much to commend them, especially in low coal where height above top of rail is an important item. The tie consists of a flat or corrugated length of steel provided with suitable means for securing the rail. They are usually spaced 4 to 10 feet apart, the rail resting directly on the room floor between ties. Their first cost is higher than the wood tie, but since they may be used over and over again, whereas the wood tie is seldom used more than twice, their ultimate cost is less. This comparison of costs is well presented in the tabulation shown below:*

Additional advantages in the use of steel ties are: (1) from 2 to 4 inches increase in working height is secured by their use; (2) in case of derailment the lift in replacing the car is reduced; (3) the reduction in height saves manual labor in loading the car; (4) miners are enabled to lay their own track without delay; (5) they are lighter in weight and easier to handle than wood ties; (6) the track is held at the required gage and is prevented from spreading; (7) if bent or broken they are easily repaired.

The life of the steel tie when used in rooms that are dry is stated to be five to ten years. In wet mines where the waters are heavily charged with acids the life may be very short. A coating of coal tar or asphaltum, applied by dipping the tie, serves as a protection against corrosion. As a further means of guarding against rust, a small percentage of copper may be added to the steel tending to make it non-corrosive.

COMPARISON OF INSTALLATION AND MAINTENANCE COSTS BETWEEN WOOD TIES AND STEEL TIES FOR ROOM WORK IN MINES.

Based on room 280′ long with steel ties spaced at 4′ 0″ center to center and wood ties 2′ 0″ center to center.

This estimate contemplates using each wood tie in two consecutive rooms and after the 2nd year renewing annually 15 per cent of steel ties, or 10 new ties per year per room.

NUMBER OF TIES IN ONE ROOM		(STEEL) 70			(WOOD) 140	
Cost of Ties f. o. b. mine in carload lots		(at.29)		$20.30	(at.06)	$ 8.40
560 Spikes					(at.00½)	2.80
Laying in 1st room		(at.02)	$1.40		(at.04)	5.60
Taking up when room worked out		(at.01)	.70		(at.02)	2.80
Maintenance cost for 1st room Steel Ties			$2.10	2.10		
Total cost at end of life of 1st room				$22.40		$19.60
Laying in 2nd room		(at.02)	$1.40		(at.04)	5.60
560 Spikes					(at.00½)	2.80
Taking up when room worked out		(at.01)	.70			
Maintenance cost for 2nd room Steel Ties			$2.10	2.10		
Total cost at end of life of 2nd room				$24.50		$28.00
Saving per room in favor of Steel Ties	$3.50					
10 new Steel Ties		(at.29)	$2.90			
10 old ties, scrap credit		(at.05)	.50			
			$2.40			
140 New Wood Ties					(at.06)	$ 8.40
560 Spikes					(at.00½)	2.80
Laying in 3rd room		(at.02)	$1.40		(at.04)	5.60
Taking up when room worked out		(at.01)	.70		(at.02)	2.80
Maintenance cost for 3rd room Steel Ties			$4.50	$ 4.50		
Total cost at end of life of 3rd room				$29.00		$47.60
Saving per room in favor or Steel Ties	$18.60					
10 new Steel Ties, less scrap credit			$2.40			
560 Spikes					(at.00½)	2.80
Laying in 4th room		(at.02)	$1.40		(at.04)	5.60
Taking up when room worked out		(at.01)	.70			
Maintenance cost for 4th room Steel Ties			$4.50	$ 4.50		
Total cost at end of life of 4th room				$33.50		$56.00
Saving per room in favor of Steel Ties	$22.50					

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*From Catalog of Carnegie Steel Co.

GRADES

One of the chief considerations in opening a coal mine is the selection of a point of low elevation so that gravity will be in favor of the movement of loaded cars. The ideal line in standard railroad location is a straight and level line since loaded cars are moving in each direction. In mines where loaded and empty cars move in one direction only the best grade is that in which the resistance in moving the loaded cars outward is equal to that in returning the empties. A steeper grade than this is wasteful of power both ways.

Sometimes the pitch of the seam and the location of mine opening are such that much of the haulage must be up-hill. Again, grades may be favorable in some parts of the mine and unfavorable in others, making a succession of hills, part of the line up grade, part down grade. In some cases nothing can be done to change the natural conditions. Such conditions dictate the kind of haulage to be used.

It is true, however, that in many instances where grades are adverse much may be done toward overcoming the disadvantage. Often by changing the course of an entry a few degrees a favorable grade may result. Where the bottom is irregular a profile may be made, after running a line of levels along the haulage, and by cutting down the high points and filling in the depressions a uniform grade of lesser degree can be established. The wisdom of flattening grades is apparent when it is realized that a short and steep grade may be the "ruling grade" and restrict the size of all trips passing on the haulage throughout the life of the mine. Under such conditions it has been found profitable to make cuts varying from 10 to 15 feet at the highest points, and to spend thousands of dollars in order that grades might be held under 1 per cent. on the main haulage.

Grades are expressed as the ratio of the rise (measured vertically) in a certain length of track to the length of the track (measured horizontally). Thus, a section of track with a uniform rise of 3 feet for each horizontal length of 100 feet would have a 3 per cent. grade. The proper method of determining a grade is by means of the surveyor's level and rod. In many cases it is sufficiently accurate to use a straight edge 100 inches in length. By placing one end on the rail and leveling it with an ordinary spirit level the vertical distance in inches from the other end of the straight edge to the top of rail will at once give the per cent. of grade.

The resistance due to a grade is always 20 pounds per ton of weight moving along it for each per cent of grade, this being additional to the track resistance. For instance the total resistance on a 3 per cent. grade would be (3 x 20)+30=90 pounds per ton, when 30 pounds per ton equals the track resistance.

CURVES

Curves are used to facilitate movement between tangents, from main entries into cross entries, passing to side tracks, into rooms, etc.

Because of the heavier equipment now used and the speed at which it is operated, curves of large radii are required for smooth transportation. The larger the radius of the curve is the less is the resistance offered to traffic. This resistance, expressed in terms of grade, with curves of from 30 feet to 100 feet radius, will run 0.015 ft. to 0.025 ft. per 100 feet of track for each degree of curvature.* The exact value depends upon the length of wheel base, condition of rolling stock and track, and the rate of speed.

Curves of small radii are dangerous inasmuch as they permit the locking of bumpers with the consequent derailment or wrecking of trips. Provided that the curve is of sufficient radius to prevent this and at the same time afford easy movement, nothing is gained by exceedingly flat curves, since not only does this require extra length of track and power, but moreover involves costs of entry driving, maintenance, timbering, etc.

In the movement of traffic over curves the flange of the outer wheels presses against the outside rail, tending to upset it by revolving about its base. This is resisted by the spikes as is revealed by the cutting of the base into outside spikes, the pulling up of the inside spikes, and the cutting of the tie. In standard railroad practice tie plates are used, while the rails may be doubly spiked or have braces on the outside to resist this lateral pressure. With the relatively low speeds in mines and lighter loads this difficulty in curves is present to a much slighter degree and no special provision is made for overcoming it.

Provision should be made, however, for widening the track gage on curves, since the axles are held rigidly to the bottom of the car and are thereby prevented from assuming a radial position. On sharp curves the running gear binds as the front wheel presses against the outside rail and the rear wheel against the inside rail. To overcome this an allowance should be made by increasing the distance between rails over the normal gage. The amount of this allowance will depend upon the degree of curvature, the wheel base, and the gage of track, the maximum being limited by the tread of the wheels.

Where curves must be used on heavy grades a reduction should be made in the grade used, so that the combined trip resistance, due to grade and curve, will not exceed the maximum allowed grade on the tangent. This reduction in standard railroad practice is taken as from 0.03 to 0.05 per cent. per degree. Thus with a 100 foot radius, giving approximately a 58 degree curve, having fairly clean tracks, good running equipment, etc., there would be allowable a 2.75 per cent. grade, as equaling the resistance due to a 5 per cent. grade on a tangent.

Owing to the low speeds in underground haulage it is not customary to elevate the outer rail of the curve above the inner one.

The degree of a curve is defined as the number of degrees of central angle subtended by a chord of 100 feet. The radius of a 1 degree curve is 5730 feet. The degree of a curve may be found by dividing 5730 by the radius, or, per contra, the number of feet radius divided into 5730 gives the number of degrees. This method is an approximation giving fairly close results with the curves of larger radii.

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*Coal Age, Vol. 9, pg. 959.

Frequently curves are laid off in mines by approximate methods such as the set-in-the-dark method; by board template, 10 feet long, with a middle ordinate; string and offset method; graphic method, etc. The most dependable method is with the transit, using offsets or deflection angles. The following table, based on gages of 40, 44 and 56½ inches will be found useful in providing data on curves. Where gages other than the ones in the table are in use a similar table may be constructed by using the formulae with which all engineers are familiar.

Turnouts and Deflections For Turnout Curves

FROG No.	GAGE	ANGLE	Rad. On Center Line	LEAD		Mid. Ord. 10′ Ch.	Ch. On Center Line	DEFLECTIONS FOR CHORDS OF						
				Str't.	Curv.			5′	10′	15′	20′	30′	40′	50′
2	3′-4″	28° 04′ 20″	26.67′	13.33′	13.88′	5 11/16″	12.94′	5° 22.7′	10° 48.3′	16° 20′	22° 01.3′	34° 13.4′		
	3′-8″		29.33′	14.67′	15.27′	5 1/8″	14.23′	4° 53.4′	9° 48.9′	14° 48.9′	19° 56.1′	30° 45.5′		
	4′-8½″		37.67′	18.83′	19.61′	4″	18.27′	3° 48.3′	7° 37.6′	11° 29′	15° 23.1′	23° 27.9′	32° 04.1′	
2½	3′-4″	22° 37′ 11″	41.67′	16.67′	17.11′	3 5/8″	16.34′	3° 26.4′	6° 53.5′	10° 22.1′	13° 53.1′	21° 05.9′	28° 41′	
	3′-8″		45.83′	18.83′	18.82′	3 9/32″	17.98′	3° 07.6′	6° 15.8′	9° 25.1′	12° 36.2′	19° 06.3′	25° 52.4′	
	4′-8½″		58.85′	23.54′	24.16′	2 9/16″	23.08′	2° 26.1′	4° 52.4′	7° 19.3′	9° 47′	14° 46′	19° 52.1′	25° 08.3′
3	3′-4″	18° 55′ 29″	60.00′	20.00′	20.37′	2 1/2″	19.73′	2° 23.3′	4° 46.8′	7° 10.8′	9° 35.6′	14° 28.6′	19° 28.3′	24° 37.5′
	3′-8″		66.00′	22.0Q′	22.40′	2 9/32″	21.70′	2° 10.3′	4° 20.7′	6° 31.5′	8° 42.9′	13° 08.2′	17° 38.4′	22° 15.5′
	4′-8½″		84.75′	28.25′	28.77′	1 25/32″	27.87′	1° 41.4′	3° 22.9′	5° 04.6′	6° 46.6′	10° 11.7′	13° 39′	17° 09.4′
3½	3′-4″	16° 15′ 36″	81.67′	23.33′	23.65′	1 27/32″	23.10′	1° 45.2′	3° 30.6′	5° 16.1′	7° 02′	10° 35′	14° 10.5′	17° 49.5′
	3′-8″		89.83′	25.66′	26.01′	1 21/32″	25.41′	1° 35.7′	3° 11.4′	4° 47.4′	6° 23.5′	9° 36.7′	12° 51.8′	16° 09.5′
	4′-8½″		115.35′	32.96′	33.40′	1 5/16″	32.63′	1° 14.5′	2° 29.1′	3° 43.7′	4° 38.4′	7° 28.3′	9° 59,1′	12° 31′
4	3′-4″	14° 15′ 00″	106.67′	26.67′	26.94′	1 13/32″	26.46′	1° 20.6′	2° 41.2′	4° 01.9′	5° 22.8′	8° 05′	10° 48.4′	13° 33.3′
	3′-8″		117.33′	29.93′	29.64′	1 9/32″	29.11′	1° 13.3′	2° 26.5′	3° 39.9′	4° 53.4′	7° 20.7′	9° 48.9′	12° 18.1′
	4′-8½″		150.67′	37.66′	38.06′	1″	27.38′	0° 57′	1° 54.1′	2° 51.2′	3° 48.3′	5° 42.8′	7° 37.7′	9° 33.1′
4½	3′-4″	12° 40′ 50″	135.10′	30.00′	30.33′	1 1/8″	29.87′	1° 03.6′	2° 07.3′	3° 10.9′	4° 14.7′	6° 22.5′	8° 30.9′	10° 39.9′
	3′-8″		148.50′	33.00′	33.27′	1″	32.79′	0° 57.9′	1° 55.7′	2° 53.7′	3° 51.7′	5° 47.8′	7° 44.4′	9° 41.5′
	4′-8½″		190.69′	42.37′	42.72′	25/32″	42.11′	0° 45.1′	1° 30.2′	2° 15.2′	3° 00.4′	4° 30.7′	6° 01.2′	7° 32.0′
5	3′-4″	11° 25′ 16″	166.67′	33.33′	33.35′	29/32″	33.17′	0° 51.6′	1° 43.1′	2° 34.7′	3° 26.4′	5° 09.8′	6° 53.5′	8° 37.6′
	3′-8″		183.33′	36.67′	36.91′	13/16″	36.48′	0° 46.9′	1° 33.8′	2° 20.7′	3° 07.6′	4° 41.6′	6° 15.7′	7° 50.3′
	4′-8½″		235.47′	47.00′	47.40′	5/8″	46.85′	0° 36.5′	1° 13′	1° 49.5′	2° 26.1′	3° 39.2′	4° 52.4′	6° 05.8′
6	3′-4″	9° 31′ 39″	240.00′	40.00′	40.10′	5/8″	39.86′	0° 35.8′	1° 11.6′	1° 47.4′	2° 23.3′	3° 35′	4° 46.8′	5° 58.7′
	3′-8″		264.00′	44.00′	44.20′	9/16″	43.85′	0° 32.6′	1° 05.1′	1° 37.7′	2° 10.7′	3° 15.4′	4° 20.7′	5° 26.0′
	4′-8½″		339.00′	56.50′	56.75′	7/16″	56.31′	0° 25.4′	0° 50.7′	1° 16.11′	1° 41.4′	2° 32.1′	3° 22.9′	4° 13.8′
7	3′-4″	8° 10′ 15″	326.67′	46.67′	46.82′	15/32″	46.55′	0° 26.3′	0° 52.6′	1° 18.9′	1° 45.3′	2° 37.9′	3° 30.6′	4° 23.4′
	3′-8″		259.33′	51.33′	51.51′	13/32″	51.20′	0° 23.9′	0° 47.8′	1° 11.7′	1° 35.7′	2° 23.5′	3° 11.4′	3° 59.4′
	4′-8½″		461.47′	65.91′	66.14′	5/16″	65.75′	0° 18.6′	0° 37.3′	0° 55.9′	1° 14.5′	1° 51.8′	2° 29.1′	3° 06.4′
8	3′-4″	7° 09′ 10″	426.67′	53.33′	53.47′	11/32″	53.23′	0° 20.1′	0° 40.3′	1° 00.4′	1° 20.6′	2° 00.9′	2° 41.2′	3° 21.5′
	3′-8″		469.33′	58.67′	58.87′	5/16″	58.55′	0° 18.3′	0° 36.6′	0° 54.9′	1° 13.3′	1° 49.9′	2° 26.5′	3° 03.2′
	4′-8½″	•	602.67′	75.33′	75.53′	1/4″	75.10′	0° 14.3′	0° 28.5′	0° 42.8′	0° 57′	1° 25.6′	1° 54.1′	2° 22.6′

N=Frog No.
F=Frog Angle
G=Gage of Track
L=Lead
C=Chord
R=Radius on Center Line
$N = \frac{1}{2} \cot \frac{1}{2} F$

$\text{Vers } F = \frac{G}{R + \frac{1}{2} G}$

$L = 2\,GN = (R + \frac{1}{2} G) \sin F = (R - \frac{1}{2} G) \tan F$

$R = 2\,GN^2 = LN$

$C = 2\,R \sin \frac{1}{2} F$

$\text{Mid. Ord.} = \frac{1}{2} C \times \tan \frac{1}{4} \text{Angle} = \frac{C^2}{8R}$

TURNOUTS

A turnout is a curved track by which a car may leave the main track for another. The essential parts of a turnout are the switch, the frog and the guard rail. The **switch** is the device which causes the car to turn away from the track on which it has been moving. To complete its passage it is necessary that one rail of the turnout track shall cross one rail of the main track; furthermore it is necessary that the flange of the wheel pass this crossing. The device that accomplishes this is called a **frog**. As the wheel passes through the frog there is always danger that it may be turned to the wrong side of the frog point. The device which prevents this is set opposite to the frog and is known as the **guard-rail.**

There are two kinds of switches in use, the tongue switch and split switch. The tongue switch is a short, stiff switch which in opening or closing revolves at the heel as on a pivot. When closed it makes an abrupt angle with the main track, whereas it should be tangent to the turnout curve. Tongue switches are used mainly on secondary haulages and for turning into rooms. The split switch has supplanted the tongue switch on the more important haulages. Here the switch rails are planed down at one end to a wedge point, in order that it may lay close against the track rail and thus turn the wheel in the direction intended. The terms used in designating the parts of a turnout are shown in Fig. 2.

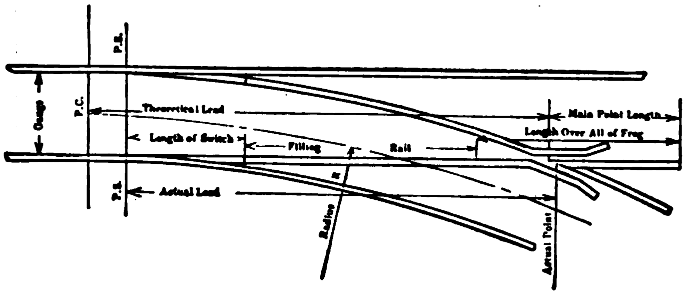
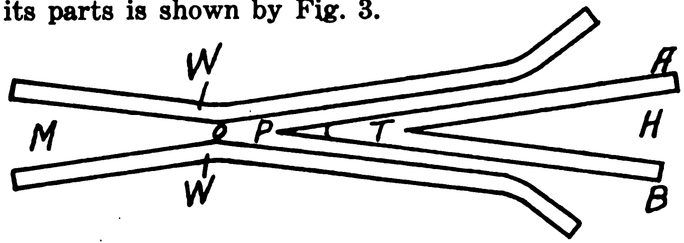


Fig. 2. Right-hand Turnout.

Frogs in use are both cast and plate. The cast steel frog is used principally at room turnouts. Frogs are sometimes made by the blacksmith at the mine, usually without a plate. The alinement is frequently bad and they lack stiffness. The plate frog, supplied by the manufacturer of track equipment, is much to be preferred and will be found more durable and cheaper in the long run. It is now customarily used on all principal haulages. When it becomes necessary to have two turnouts proceeding from the same point in the main haulage, one to the right and the other to the left, a three-way switch is used. Three frogs are required, one of which is placed at the center of the main track. This is known as a **crotch frog.** (Illustrations of the commonly used types of frogs and switches will be found on the catalog pages.)

The general shape of a frog and the name of its parts is shown by Fig. 3.



M=Mouth. WW=Wings. T=Tongue.
O=Throat. H=Heel.
P=Theoretical point, i. e., the intersection of gage lines, actual point is between P and T.

Fig. 3. Typical Frog and Its Parts. $\frac{PA}{PB}$=Point Rails.

Frogs are designated by numbers. This is found by dividing the length of the point rails by the width to gage lines at heel, that is, the number,

$$N=\frac{PH}{AB}.$$

Because of the failure to understand the important relationship of one part of a turnout to the other parts, the frog is sometimes located at the most convenient rail joint, thus changing the lead. The resulting irregularity in the curve does much to nullify all preceding efforts to have a smooth transition. With the aid of Fig. 4 the following turnout formulae provides the means for finding the lead for various gages, frog numbers, etc.* These figures are for turnouts with straight frogs and switches.

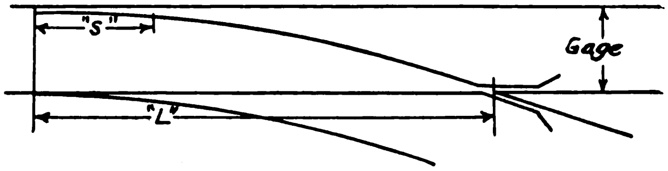


Fig. 4. Turnout, Showing Application of Formulae.

To obtain the distance "L" (lead) of a turnout when the number of the frog is 2, 2½, 3, 3½, or 4, with switch point lengths of 5'-0" or 6'-0" and the gage of track is 36 inches, proceed as follows:

Multiply the frog number, "N", by 3.9 and add the length of the switch, "S". The result will be the lead in feet and tenths of a foot, thus,

$$L=3.9\ N+S \text{ (for 36 inch gage only).}$$

To obtain the frog number when the lead is known, subtract the length of the switch point from the lead and divide by 3.9, thus,

$$N=\frac{L-S}{3.9} \text{ (for 36 inch gage only).}$$

For **40 inch gage** with No. 2, 2½, 3, 3½, or 4 frog and 5'-0" or 6'-0" switch, substitute 4.3 for 3.9 in above formulae.

For **42 inch gage** with No. 2, 2½, 3, 3½, or 4 frog and 5'-0", 6'-0" or 7'-6" switch, substitute 4.7 for 3.9 in above formulae.

For **44 inch gage** with No. 2, 2½, 3, 3½, or 4 frog and 5'-0", 6'-0" or 7'-6" switch, substitute 5.1 for 3.9 in above formulae.

For **48 inch gage** with No. 2, 2½, 3, 3½ or 4 frog and 5'-0", 6'-0" or 7'-6" switch, substitute 5.6 for 3.9 in above formulae.

For **56½ inch gage** with No. 2, 2½, 3, 3½, or 4 frog and 5'-0", 6'-0" or 7'-6" switch substitute 6.8 for 3.9 in above formulae.

For **56½ inch gage** with No. 4, 5 and 6 frog and 10'-0" switch; No. 6, 7, and 8 frog and 12'-0" switch; or No. 7, 8, 9, and 10 frog and 15'-0" switch, substitute 6.6 for 3.9 in above formulae.

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*Data furnished by the Cincinnati Frog & Switch Company.

CROSSINGS AND CROSS-OVERS

Track crossings are needed where two lines of track intersect. The most serviceable crossing is made by riveting the frogs to base plates. The crossing should be firmly set on ample ties. Track crossings are dangerous in underground operation owing to the likelihood of collision although considerable may be done to guard against this by adopting a good system of signalling.

Double cross-overs are used at shaft bottoms to permit the passing of loaded cars from one side of the bottom to the other. They are found whereever double tracks are in use and extending a considerable distance back from the shaft. If the loaded cars on one track have all been caged off, with some loads remaining on the parallel track, the cross-over enables the passing of a sufficient number of loaded cars to provide both cages with loaded cars. Fig. 5 shows the construction of a typical cross-over.

Double Cross Over.

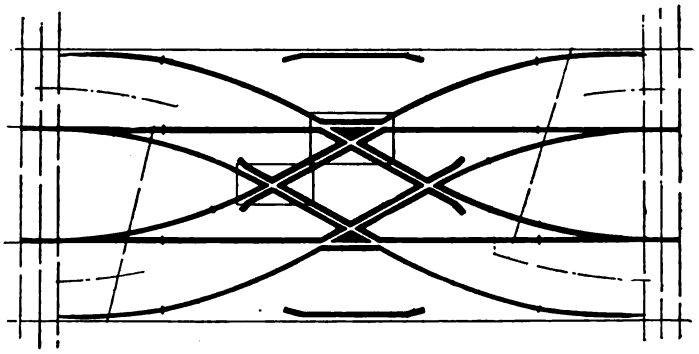
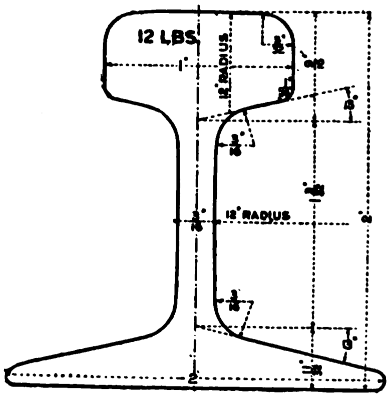
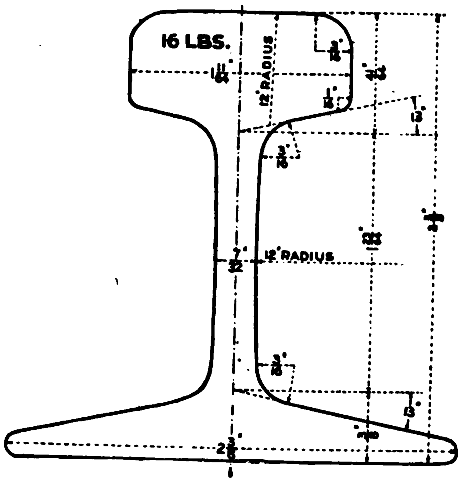
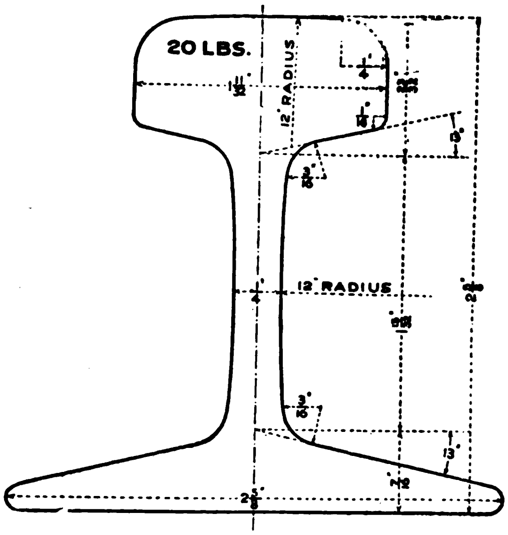


Fig. 5. Double Cross-Over As Constructed When Distance Between Tracks Is Greater Than Gage of Track.



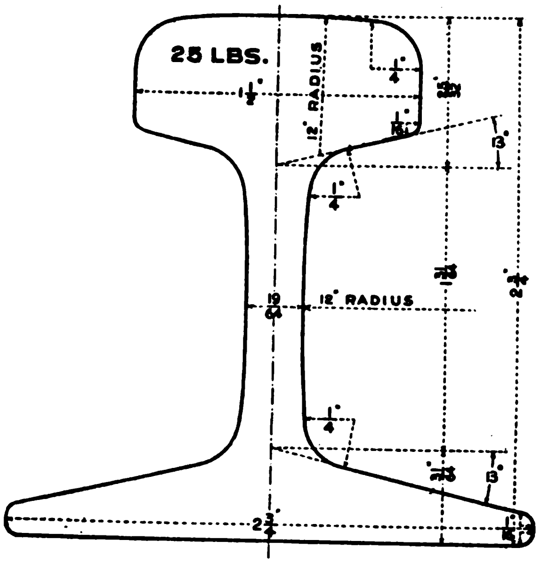


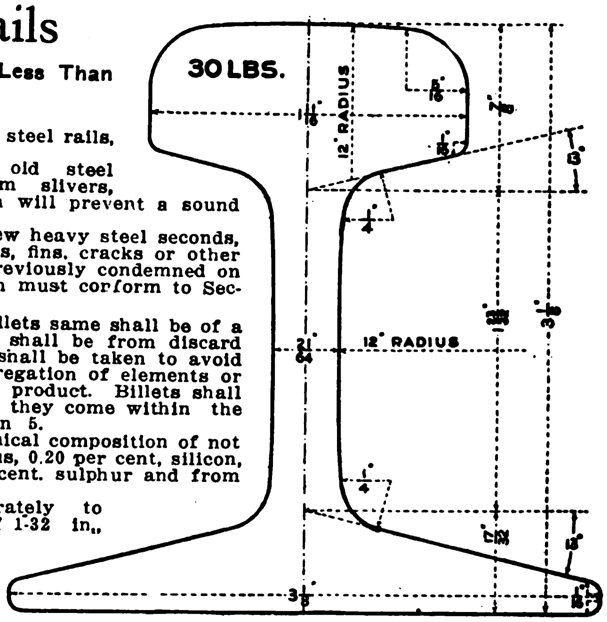


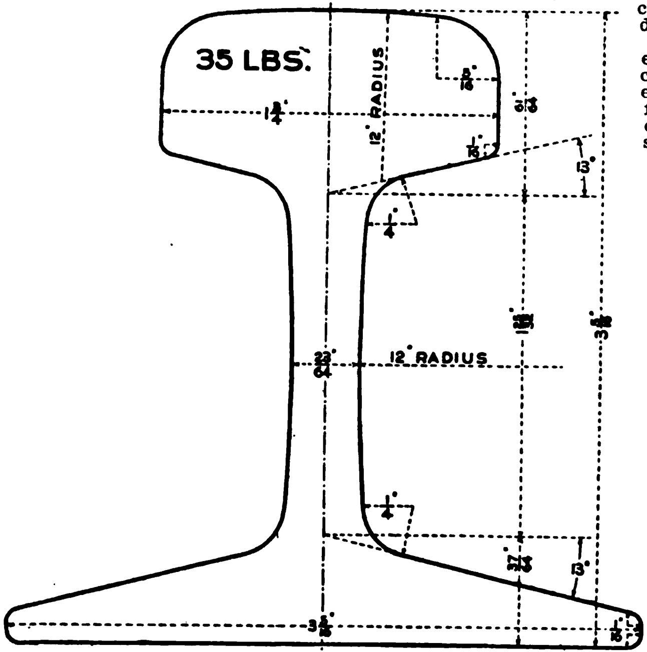
Light Steel Rails

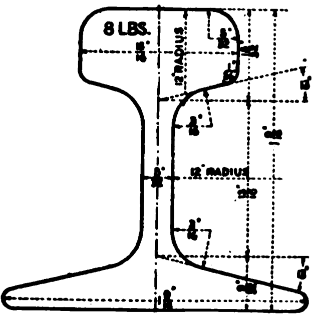
A. S. C. E. Sections, Weighing Less Than 45 Pounds Per Yard.

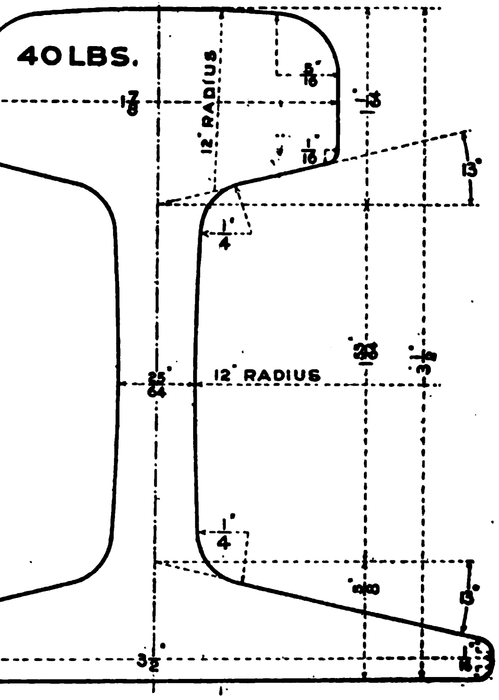
1. Rails may be rolled from old steel rails, heavy seconds or from billets.
2. When rails are rolled from old steel rails, the stock shall be free from slivers, fins, cracks or other defects which will prevent a sound finished product.
3. When rails are rolled from new heavy steel seconds, the stock must be free from slivers, fins, cracks or other defects, and must not have been previously condemned on account of chemical analysis, which must conform to Section 5 below.
4. When rails are rolled from billets same shall be of a uniform character of steel. None shall be from discard of ingots, and special precautions shall be taken to avoid the use of billets with piping, segregation of elements or slag which will roll to an unsound product. Billets shall not be used from off heats, unless they come within the chemical analysis given in Section 5.
5. Rails shall conform to a chemical composition of not more than 0.10 per cent. phosphorous, 0.20 per cent. silicon, 0.80 per cent. manganese, 0.06 per cent. sulphur and from 0.30 to 0.50 per cent. carbon.
6. Section shall conform accurately to template. A variation in height of 1-32 in., either more or less, will be permitted.
7. Rails will be accepted and paid for according to weight, and a variation of 1 per cent permitted.
8. The Standard length of rails shall be 30 ft., with mill lengths down to 22 ft., permitted.
9. Rails to be either drilled or punched with circular holes, and splice bars punched with elliptical holes; same to conform to standard sizes and distances.
10. Rails shall be straightened while cold, free from cracks, slivers, injurious seams, evidence of burning or other defects; they shall be sawed at ends within 1-16 inch of exact square.











Courtesy United States Rail Co.

Frog and Switch Data

Give the following data when sending inquiries:

Height of rail ....

Weight of rail ....

Distance from end of rail to center of first splice hole. ....

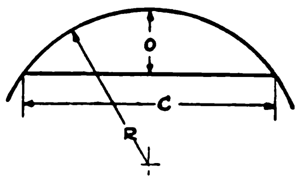
Distance from center of first splice hole to center of second splice hole. ....

Angle in degrees and minutes or number of Frog. ....

Length of switch points. ....

Gauge of track ....

Curvature of Track Rails



Middle Ordinates (O) for Curves of Various Radii (R), on Chords (C) of Various Lengths.

Curvature		Length of Chord (C), Feet					
		10	15	20	25	30	50
Radius (R). Feet	Degrees	Height of Ordinate (O), Inches					
10	....	16.08	40.56	120.00	......	......	......
15	....	10.33	24.24	45.85	80.40	180 00	......
20	286° 38′ 36″	7.69	17.28	32.16	52.55	81.25	.....
25	229° 18′ 27″	6.00	13.56	25.10	40.20	60.00	300.00
30	191° 5′ 25″	4.20	10.67	17.53	27 66	40.60	120 00
50	114° 39′ 17″	3.00	6.84	12.12	19.07	27 66	84.00
75	76° 26′ 10″	2.01	4.56	8.04	12.50	18 20	51 56
100	57° 19′ 38″	1.51	3.36	6.03	10.02	13.58	38.20
125	45° 51′ 42″	1.20	2 76	4 81	7.51	10 86	30.32
150	38° 13′ 5″	1.01	2 28	4.01	6.31	9.03	26.00
200	28° 39′ 49″	.77	1 74	3.00	4.69	6.78	18.84
250	22° 55′ 51″	.60	1 44	2.40	3.76	5.41	15 06
500	11° 27′ 56″	.30	72	1.21	1.87	2.71	7.52
750	7° 38′ 37″	.22	.46	.80	1.32	1.81	5.01
1000	5° 43′ 58″	.16	.34	.60	.94	1.36	3.76

Courtesy Goodman Manufacturing Co.

FROG AND SWITCH DATA

No. Frog	Spread Per Foot	Frog Angle	RADIUS CURVE IN FEET					Switch Points Suitable Lengths
			Gauge 3 0″	Gauge 3′ 6″	Gauge 3′ 8″	Gauge 4′ 0″	Gauge 4′ 8½″	
1	12″	53° 0′	6.00	7.00	7.33	8.00	9.41	4′ 0″
1¼	9⅝″	43° 40′	9.36	10.93	11.44	12.50	14.68	4′ 0″
1½	8″	36° 52′	13.50	15.75	16.50	18.00	21.19	4′ 0″
1¾	6⅞″	31° 53′	18.31	21.44	22.44	24.42	28.74	4′ 0″
2	6″	28° 04′	24.00	28.00	29.33	32.00	37.65	5′ 0″
2¼	5 11/32″	25° 03′	30.37	35.44	37.12	40.50	47.67	5′ 0″
2½	4 13/16″	22° 37′	37.50	43.75	45.83	50.00	58.85	5′ 0″
2¾	4⅜″	20° 37′	45.37	52.94	55.44	60.50	71.71	5′ 0″
3	4″	18° 55′	54.00	63.00	66.00	72.00	84.75	7′ 0″
3¼	3 11/16″	17° 30′	63.37	73.94	77.37	84.50	99.46	7′ 0″
3½	3 15/32″	16° 16′	73.50	85.75	90.00	98.00	115.27	7′ 0″
3¾	3 3/16″	15° 11′	84.37	98.44	107.21	116.96	137.57	7′ 0″
4	3″	14° 15′	96.00	112.00	117.33	128.00	150.66	7′ 0″
4¼	2 27/32″	13° 26′	108.37	126.43	132.45	144.50	169.79	7′ 0″
4½	2 21/32″	12° 41′	121.50	141.75	148.50	162.00	190.60	10′ 0″
5	2 13/32″	11° 25′	150.00	175.00	183.33	200.00	235.40	10′ 0″

Courtesy Helmick Fdy. & Machine Co.

RAILROAD SPIKES

Size Measured Under Head	Average No. per Keg of 200 Lbs.	Ties Two Feet Between Centers; Four Spikes per Tie Makes per Mile	Rail Used Weight per Yard
5½x9-16	360	5920 lbs. 29 1-3 kegs	45 to 100
5 x9-16	405	5230 lbs. 26 kegs	40 to 56
4½x9-16	460	4606 lbs. 23 kegs	35 to 40
5 x½	505	4460 lbs. 21 kegs	
4½x½	535	3960 lbs. 19 4-5 kegs	30 to 35
4 x½	605	3515 lbs. 17½ kegs	25 to 35
3½x½	670	3180 lbs. 15⅞ kegs	20 to 30
4½x7-16	690	3090 lbs. 15½ kegs	
4 x7-16	780	2739 lbs. 13 3-5 kegs	
4½x⅜	780	2730 lbs. 13 3-5 kegs	16 to 25
3½x7-16	890	2377 lbs. 12 kegs	
4 x⅜	1025	2044 lbs. 10 1-5 kegs	
3½x⅜	1250	1740 lbs. 8½ kegs	16 lbs.
3 x⅜	1380	1592 lbs. 8 kegs	
2½x⅜	1650	1280 lbs. 6 2-5 kegs	12 lbs.

RAILS Tons per mile required of following weights per yard.

Weight per Yard	Tons 2240 Lbs. per Mile.
12 lbs.	18.86
16 lbs.	25.14
20 lbs.	31.43
25 lbs.	39.29
30 lbs.	47.14
35 lbs.	55.00
40 lbs.	62.86
45 lbs.	70.71
50 lbs.	78.56
56 lbs.	88.00
60 lbs.	94.29
65 lbs.	102.14
70 lbs.	110.00
75 lbs.	117.86
80 lbs.	125.71
85 lbs.	133.57
90 lbs.	141.43
100 lbs.	157.14

CROSS TIES

Per Mile.

Center to Center.	No. Ties
18 inches	3520
21 inches	3017
24 inches	2640
27 inches	2348
30 inches	2113

SPLICE JOINTS

Per Mile

Two bars to each joint.

Rails 20 feet long 528 joints.
Rails 24 feet long 440 joints.
Rails 30 feet long 352 joints.
Rails 33 feet long 320 joints.

Courtesy W. Va. Rail Co.

Comparative table showing price in Gross Tons of 2240 lbs. with corresponding price in Net Tons of 2000 lbs. and price per Cwt.

Gross Ton	Net Ton	Cwt.	Gross Ton	Net Ton	Cwt.
$25.00	$22.32	$1.116	$32.75	$29.24	$1.462
25.25	22.54	1.127	33.00	29.46	1.473
25.50	22.76	1.138	33.25	29.68	1.484
25.75	22.99	1.149	33.50	29.91	1.495
26.00	23.21	1.160	33.75	30.13	1.506
26.25	23.43	1.171	34.00	30.35	1.517
26.50	23.66	1.183	34.25	30.58	1.529
26.75	23.88	1.194	34.50	30.80	1.540
27.00	24.10	1.205	34.75	31.02	1.551
27.25	24.33	1.216	35.00	31.25	1.562
27.50	24.55	1.227	35.25	31.47	1.573
27.75	24.77	1.238	35.50	31.69	1.584
28.00	25.00	1.250	35.75	31.91	1.595
28.25	25.22	1.261	36.00	32.14	1.607
28.50	25.44	1.272	36.25	32.36	1.618
28.75	25.66	1.283	36.50	32.58	1.629
29.00	25.89	1.294	36.75	32.81	1.640
29.25	26.11	1.305	37.00	33.03	1.651
29.50	26.33	1.316	37.25	33.25	1.662
29.75	26.56	1.328	37.50	33.48	1.674
30.00	26.78	1.339	37.75	33.70	1.685
30.25	27.00	1.350	38.00	33.92	1.696
30.50	27.23	1.361	38.25	34.15	1.707
30.75	27.45	1.372	38.50	34.37	1.718
31.00	27.67	1.383	38.75	34.59	1.729
31.25	27.90	1.395	39.00	34.82	1.741
31.50	28.12	1.406	39.25	35.04	1.752
31.75	28.34	1.417	39.50	35.26	1.763
32.00	28.57	1.428	39.75	35.49	1.774
32.25	28.79	1.439	40.00	35.71	1.785
32.50	29.01	1.450			

RULE:

To convert price per Gross Ton into price per net ton, divide by 1.12.
To convert price per Net Ton into price per Gross Ton, multiply by 1.12.
To convert price per Gross Ton into price per 100 lbs. divide by 22.4.

Courtesy W. Va. Rail Co.

THE BUCKEYE ROLLING MILL CO.

General Offices: Steubenville, O.

MILLS, NEWARK, OHIO.

BUCK-EYE
RAILS

BRANCH OFFICES:
CHICAGO, ILL.—Wilmer Wickersham, 1850 Peoples Gas Bldg.
CLEVELAND, OHIO—The Hamill-Hickox Company, Hickox Bldg.
ST. LOUIS, MO.—C. E. Hutchinson, Suite 913 Federal Reserve Bank Bldg.
NEW YORK, N. Y.—Hudson Terminal Bldg., 30 Church St.
KANSAS CITY, MO.—R. A. Long Bldg.

BUCK-EYE
RAILS

Products

Exclusively Manufacturers of Light Steel Rails and Accessories—Splice Bars, Bolts, and Nuts.

Two things are especially essential to users of Light Steel Rails:

QUALITY AND QUICK DELIVERY.

BUCKEYE RAILS are the STANDARD FOR QUALITY, and have been all the years we have been in business.

QUICK DELIVERY is our specialty, whether you want one ton or one hundred.

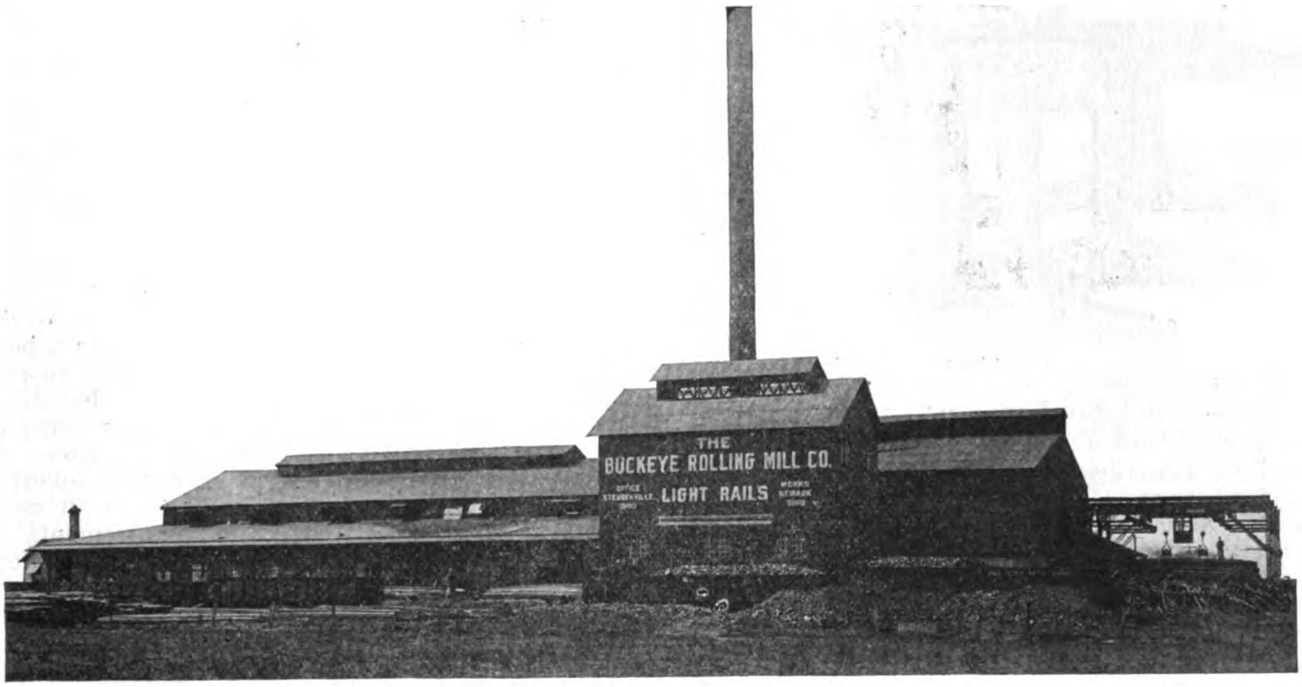
Special lengths furnished if desired.

Let Us Have Your Next Order

Inspection

Our products are all carefully inspected, as made, at our mills, and not on paper.

We want you to look them over, at your end of the line. That's the inspection that counts, after all. Our guarantee does the rest.



The Best Equipped Light Steel Rail Mill in the Country.

SWEET'S STEEL COMPANY

Mills and General Offices
WILLIAMSPORT. PA.
Branch Offices
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WILKES-BARRE, Miner's Bank Building
Manufacturers of

Steel Rails, Steel Cross Ties and Appurtenances

Products.

Light Steel Tee Rails, Steel Ties and appurtenances; Light Steel Angles; Light Steel Flats and Bands; Steel Concrete Reinforcement Bars.

Facilities.

A large plant, equipped with modern machinery, and possessing very favorable and advantageous shipping facilities, warrants prompt and quick delivery of the material.

Light Steel Rails and Fastenings.

SWEET'S STEEL COMPANY, the largest independent manufacturers of light section tee rails in the United States, roll these rails (standard A. S. C. E. sections) from high-grade stock of new first quality, which is required to pass severe chemical and physical tests necessary to insure a thoroughly satisfactory rail section. Under Sweet's construction, a uniform product, made from steel suitable for hard usage, is secured, without flaws or defects due to segregation of various metal compositions (Fig. 1).

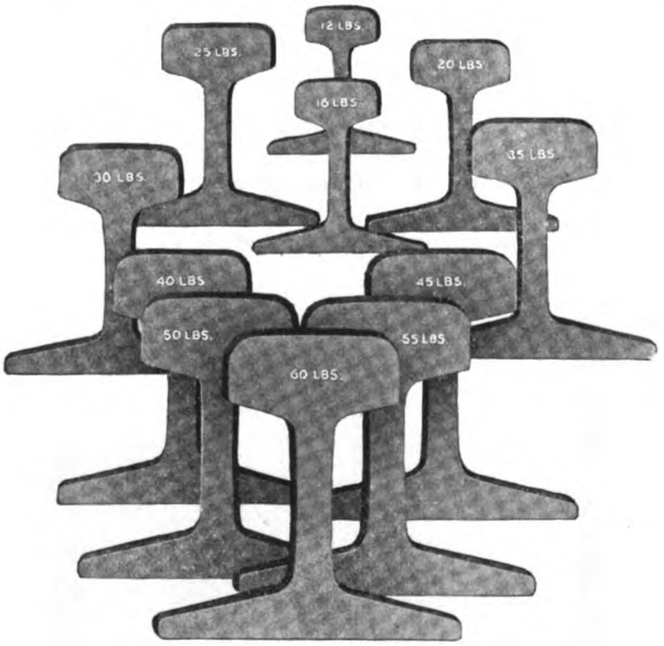


Fig. 1. Line of Light Steel Rails
Manufactured by Sweet's Steel Company, Williamsport, Pa.

Sizes—Light Steel rails are rolled 12, 16, 20, 25, 30, 35, 40, 45, 50, 55 and 60 pounds per yard.

Lengths—Steel rails are furnished in regular standard lengths with splice bar punching, and rolled in accordance with specifications as set forth by the American Society of Civil Engineers. Rails in any special length, such as all 15, 20, or 24 feet, also supplied.

Splice Bars—Furnished complete with bolts and nuts for 12, 16, 20, 25, 30, 35 and 40 pound rails.

Angle Bars—Furnished complete with bolts and nuts for 30, 35, 40, 45, 50, 55 and 60 pound rails. also supplied. Bond drilling furnished when required.

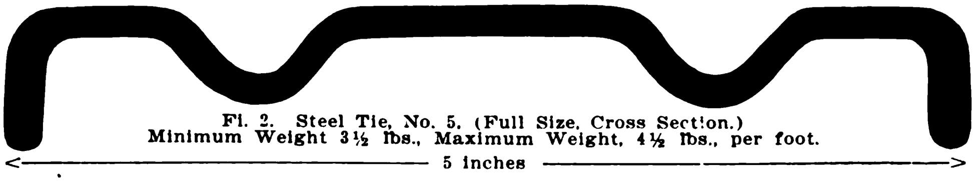
Line Drawings—Complete specifications with full sets of line drawings, or catalog of rails and splice bars made by SWEET'S STEEL COMPANY, in all sections as shown in Fig. 1, will be forwarded on request. Such drawings or catalog are accompanied with complete information regarding weights, sizes, dimensions and punching of rails; punching and weight of splice bars, per pair; weight of bolts per joint; sizes of steel spikes and bolts, etc.

Steel Ties and Fastenings.

For portable, industrial or mine track, in place of wood ties. Recommended for 12, 16, 20, 25, 30, 35, 40, and 45 pound rails. Tie spacing, about 15 ties to the 30-foot rail. Life of steel ties, laid in ballast, is about twenty years and is indefinitely prolonged by immersing ties (when heated to 500 degrees Fahr.) in hot coal tar (Fig. 2).

The designing and rolling of our Steel Cross Tie Section No. 5, for Permanent, Portable, Industrial or Mine Track is an evolution, and was not decided upon until after an exhaustive study on the part of our Engineering Department had been made of the several Cross Tie Sections now on the market. In the designing of our Section, we have not only eliminated the weak points of other Sections, but have strengthened the strong points. One of the prime factors making this possible is that we roll our Steel Ties from High Carbon Steel; in other words, the Carbon content of the Steel from which we roll is two or three times higher than that used in the rolling of competitive Tie Sections. This combined with the double corrugated feature of the Tie, affords much greater resiliency, and at the same time greater rigidity, than any other similar Section on the market. One other important feature with out Tie Section is that the double corrugation permits of the attaching of Tee Head Bolts and Clips directly opposite each other, which is a distinct mechanical advantage. We will touch upon this point more in detail later.

Many tests have been made on our Ties to determine physical properties. These tests have been made under the supervision of the largest Inspection Agencies in the United States, on behalf of several Foreign Governments, as well as many of the largest consumers in the United States, for whom we have executed large contracts covering Portable Track Materials. The tests in all cases exceeded the expectations and requirements of clients. The significance of this will be obvious when it is borne in mind that rarely, if ever, are any specifications covering materials more rigid than those of Government requirements. We submit for your careful consideration the following test covering physical properties of our Steel Tie Section No. 5:



Fi. 2. Steel Tie, No. 5. (Full Size, Cross Section.)
Minimum Weight 3½ lbs., Maximum Weight, 4½ lbs., per foot.

This Tie rolled 3½ lbs. per foot Is Particularly Recommended for 12, 16, 20, 25, and 30 lb. Rails. The Same Tie Rolled to Heavier Weights is Recommended For The Heavier Rail Sections. 30 lb. to 45 lb. per Yard Inclusive.

The Bending Test below was continued, applying force until a maximum of 3600 pounds was reached. At this weight, the Tie showed a deflection representing an Angle of approximately 45 degrees. The Tie, even though bent to this Angle, was entirely free from any indication of fracture, the legs of the Tie retaining their original alignment throughout the entire Test, showng no bulging in the legthwise position.

As a basis for comparison, we were obliged to make a test on a competitive Tie Section, similar in weight and general dimensions to our Section No. 5. In making this Test, identically the same procedure was involved as outlined in the forgoing, the result being that the Elastic Yield Point of the competitive Section was found to be between 1,000 and 1,100 pounds. After the application of a force of 1,200 pounds, the Te Section showed a permanent set of 9/32". The application of force was continued until 1800 pounds was recorded; the Tie then showed a permanent set of ⅜".

A comparison of the two Tests just outlined will serve to substantiate the claims we set forth in the first paragraph. Tests being so obviously in favor or our No. 5 Tie Section, further remarks are unnecessary.

Physical Properties of Steel Cross Ties, Section No. 5					**Results obtained from bending test. Weight of tie 3.5 lbs. per foot. Length 40 inches. Load applied at center. Supports 2'-0" from center to center.**		
Tie Section No. 5, Weights Per Foot	Area in Square Inches	Moment of Inertia	Section Modulus	Distance of Neutral Axis from Base	Load Applied Pounds	Actual Deflection Inches	Theoretical Deflection Inches
					1500	.312	.379
3.5 lb	1.03	.038	.675	.561	1700	.500	.419
					1900	.561	.480
					2000	.561	.507
4.0 lb	1.17	.044	.770	.572	2100	.561	.530
					2200	.625	.555
					2300	.625	.581
4.5 lb	1.32	.053	.905	.584	2400	.687	.606
					2500	.720	.633
					2550	Elastic Yield Point	.644
					2600	.875	.656

METHOD OF ATTACHING RAILS TO TIES

It is a well known fact that the placing of the Fastenings attaching Rails to Ties directly opposite each other over the flange of the Rails, using for this purpose Tee Head Bolts and Clips (see figures 4, 5, and 6), represents greater engineering and mechanical efficiency than the so-called staggering of Clips, which idea has been fostered and advocated by some few competitive companies rolling a Tie Section, the general character of which prohibits the placing of Tee Head Bolts and Clips opposite each other. By way of explanaition, we might add that it is generally assumed that the Engineers designing some of the primitive Tie Sections obtained their idea of staggering Clips and Tee Head Bolts from the old practice of staggering Spikes when attaching Rails to wooden Ties. It is quite obvious that this practice was not employed because of its representing any special mechanical efficiency, but was entirely due to the likelihood that the wooden Tie would split if the two Spikes were placed directly opposite each other. The use of Tee Head Bolts and Clips as a means of fastening Rails to Ties is not original with us, this method having been employed satisfactorily for many years, and is still conceded by Engineers and users to be by far the most practical, even in view of the fact than many methods of later design are being advocated.

Our Portable Track Materials are all accurately rolled and punched, ready for fabrication. The work of quickly and accurately laying Track is so simplified that even the most inexperienced laborer can perform his duties efficiently.

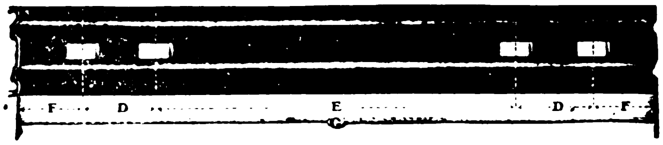


Fig. 3. Steel tie, section No. 5, rolled to a weight of 3½ to 4½ lbs. per foot. This tie is particularly recommended for the full range of light steel rails.

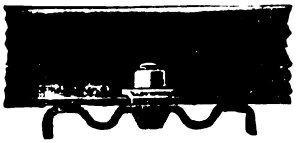


Fig 4. Cross-section of tie and end view of clip.

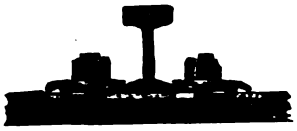


Fig. 5. Cross-section showing clips attached to rail and tie.

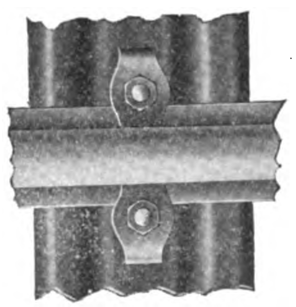


Fig. 6. Top view showing clips attached to rail and tie.

UNITED STATES RAIL COMPANY

Main Office and Rolling Mills

CUMBERLAND, MD.

Largest Independent Manufacturers of

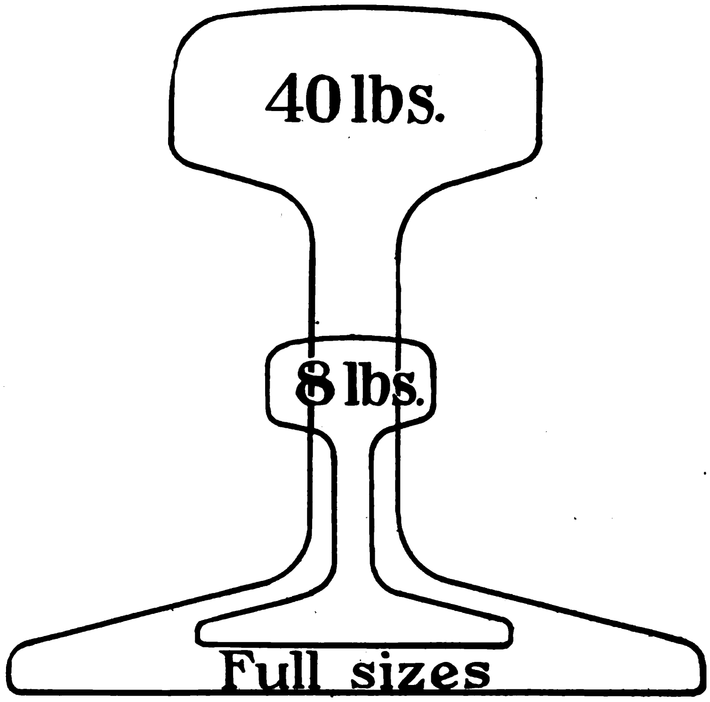
Standard A. S. C. E. Section

LIGHT STEEL RAILS

HENRY SHRIVER, President.
H. E. WEBER, First Vice-President.

W. M. ROBERTS, JR., Second Vice-President.
T. F. SHANNON, Secretary-Treasurer.

Plain and Angle
Splice Bars.



Bolts and Spikes.
Frogs and Switches.

8, 12, 16, 20, 25, 30, 35, and 40 lbs. per yard.

All rails rolled by us are inspected by Hildreth & Co., Inspecting Engineers of New York City, whose inspectors are stationed at our plant, at Cumberland, Md., in the interest of customers.

WE CAN FURNISH RAILS CUT TO SPECIAL LENGTHS FOR ALL PURPOSES.

WRITE FOR PRICES. **ANY QUANTITY.**

THE WEST VIRGINIA RAIL CO.

Mills and General Office: Huntington, W. Va.

Manufacturers of

Light Steel Rails, Joints and Spikes.

and Dealers in

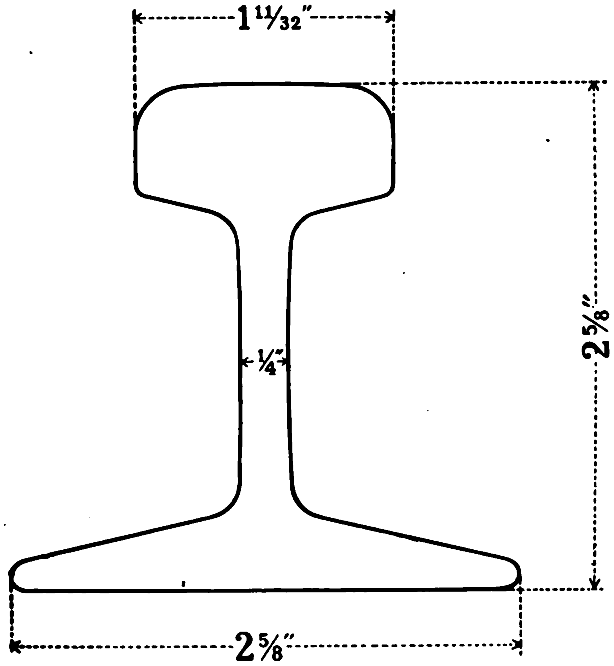
Relaying Rails All Sizes

We manufacture rails from 12 to 45 lbs. inclusive. For the past ten years we have devoted our entire attention exclusively to making good first quality light rails. We are rail experts and you will find our satisfied customers in every mining state in the Union. Wherever there are mines you find the name of West Virginia Rail Company stands for quality and integrity.

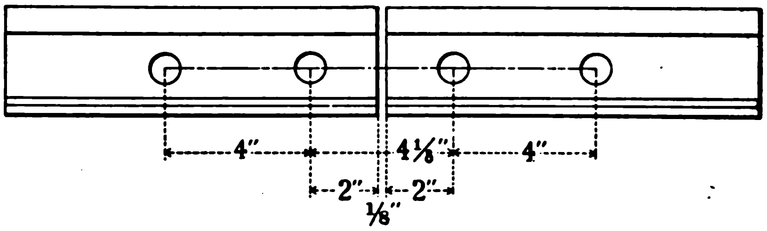
We carry a large stock of rails as well as splices, bolts and spikes on hand and can give prompt shipment at all times.

Send for our Bulletin which gives you valuable rail data, including rail dimensions, number of spikes in keg, number of cross ties required per mile, number of tons required per mile of track of various size rail; also comparative table giving price equivalent in gross ton, net ton and cwt.

"All our rails are A. S. C. E. Section."

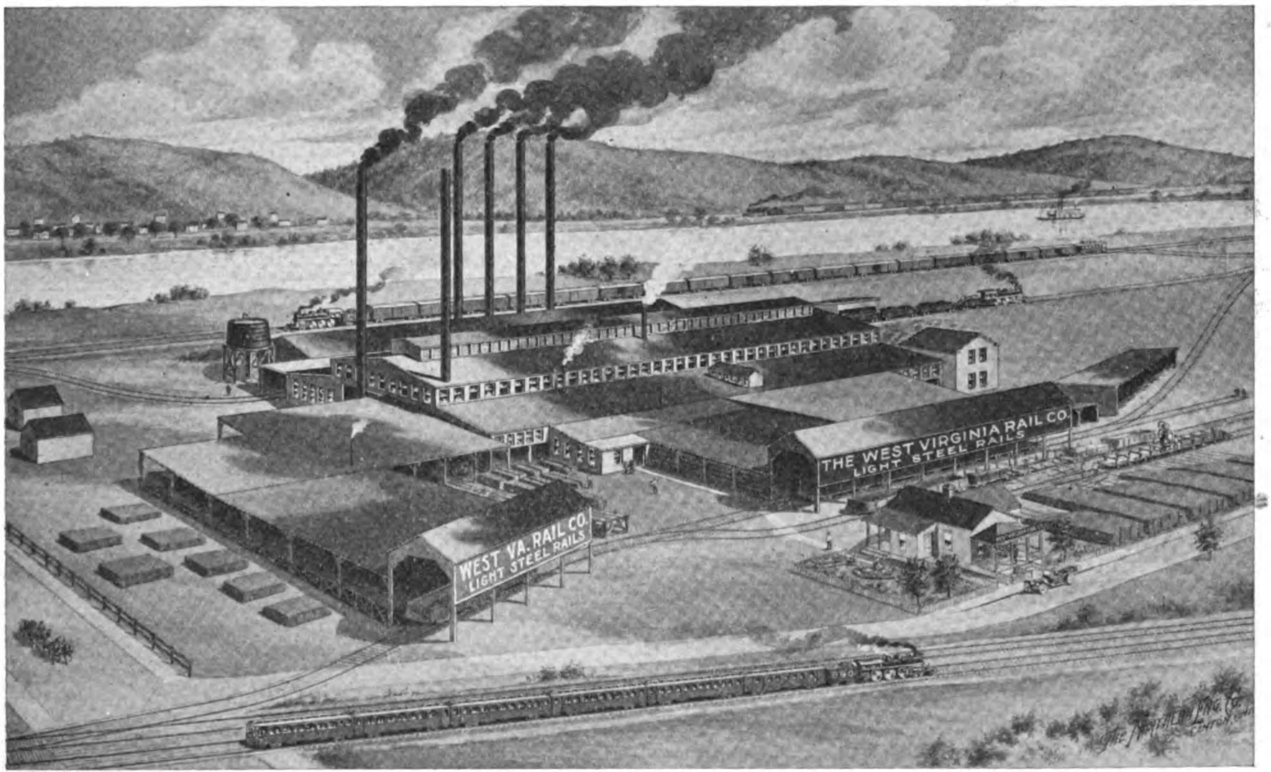


20 Lbs. per Yard
31.43 Gross Tons per Mile of Single Track
168 Feet of Single Track per Gross Ton.



Center of Web
Diameter of Holes 5/8 Inch.

We are also dealers in Relaying Rails, all sizes.


THE WEST VIRGINIA RAIL CO.
LIGHT STEEL RAILS
WEST VA. RAIL CO.
LIGHT STEEL RAILS

Contractors Machinery & Supply Co.

General Offices
509-511 WABASH BLDG., PITTSBURGH, PA.
Warehouse
2 Rutherglen St., Pittsburgh, Pa.

New and Used Machinery and Equipment for Mines

Products

New and used Compressors, Hoisting Engines (steam, electric, gasoline), Pumps, Steam Shovels, Locomotives, Boilers, Engines, Grab and Orange Peel Buckets.

New and Relaying Rails in stock from 8 to 100 pounds, Frogs, Switches, Mine Cars, Portable Track, Track Accessories, Bolts, Spikes, Splice Bars.

Standard and Narrow Gauge Locomotives, all sizes, steam, gasoline, electric,air.

Pipe.

All sizes, both new and used.

Locomotive Cranes

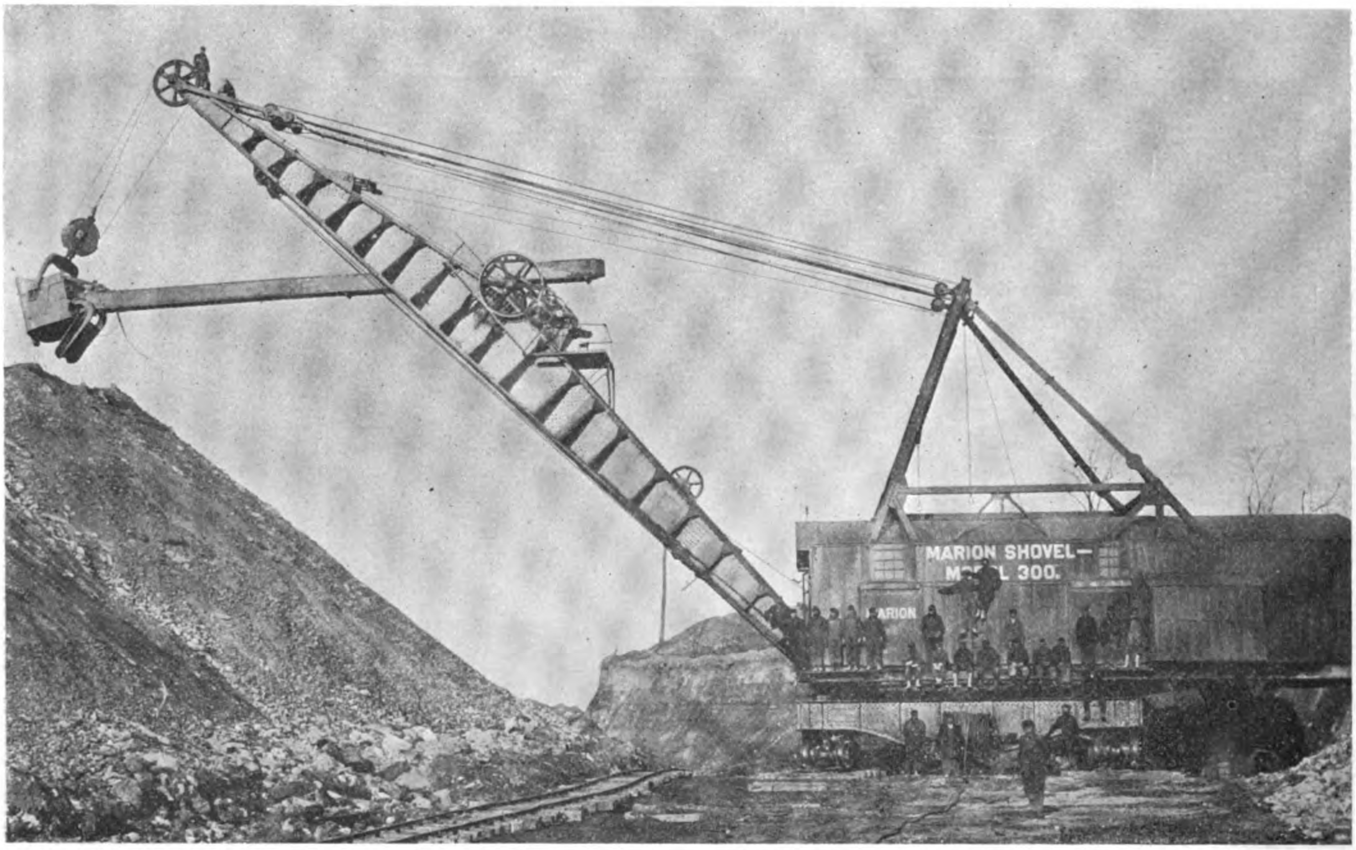
10, 15, 20 and 30-ton capacities, both 4 and 8 wheel machines with grab buckets for handling coal.

We are machinery jobbers and not brokers. We maintain at Pittsburgh large machine shops where all used equipment is overhauled and given a running test. All equipment guaranteed.

Send for our monthly stock list.

We carry in stock complete coal stripping outfits—Steam Shovels; Locomotives; Cars; Rails.

PHONE WIRE WRITE



L. B. FOSTER COMPANY

PITTSBURGH, PA.

Rails--New and Relaying, Second-Hand Pipe and Equipment

Relaying Rails

500 tons 90 lb. with Angle Fish Plates.
2500 tons 85 lb. " " " "
2000 tons 70 lb. " " " "
500 tons 67 lb. " " " "
300 tons 65 lb. " " " "
2000 tons 60 lb. " " " "
1500 tons 56 lb. " " " "
150 tons 50 lb. " " " "

300 tons 45 lb. with angle and Fish Plates.
500 tons 40 lb. " " " "
200 tons 40 lb. " Plain " "
700 tons 35 lb. " Angle " "
200 tons 30 lb. " " " "
200 tons 30 lb. " Plain " "
200 tons 25 lb. " Angle " "
200 tons 25 lb. " Plain " "

Rails Cut to Lengths for Special Purposes

All Relaying Rails average 30 ft. in length, uniform in section, height and drilling, straight, free from surface bends, breaks, kinks or splits and show very little wear. Inspection during loading or subject to inspection and approval at destination point. Quick shipment guaranteed.

New Rails

200 tons 8 lb. per yard.
300 tons 12 lb. " "
500 tons 16 lb. " "
300 tons 20 lb. " "
With complete Plain Splices.

500 tons 25 lb. per yard.
500 tons 30 lb. " "
500 tons 35 lb. " "
500 tons 40 lb. " "
With complete Angle or Plain Splices.

New Rails available for quick shipment in carload or less carload lots, at MANUFACTURERS' PRICES. Can drill for bonding or cut to special lengths.

Rail Splices—(New and Second-Hand.)

For years we have made a specialty of supplying Splice Bars, Angle and Plain, in any quantity, guaranteed to fit all sections no matter how old or how modern the Rail. We have the patterns for all drillings and sections, sizes 8 lbs. to 125 lbs. Can furnish with or without Bolts. To secure accurate fit send by express collect, a sample of bar or template.

We make Combination Splices to connect Rail sections of different height and drilling.

Second Hand Pipe.

All sizes from ¼ in. to 24 in. for Steam, Water, Gas and Oil Lines. Can save you 30% to 50% on Second-hand Pipe and guarantee materials to give service equal to that of New Shipments subject to inspection and approval at destination point. New Pipe at Manufacturers' prices.

Frogs and Switches—(New and Second-Hand.)

All kinds of Regular and Industrial Track work for Steam and Electric Railroads, Mines, Contractors, Quarries and Logging Railroads. Portable Track.

Track Accessories

- Bolts, Nuts
- Spikes
- Tie Plates
- Rail Braces
- Car Movers
- Rail Benders
- Rail Forks
- Rail Tongs
- Drills and Saws.

Second-Hand Equipment

- Locomotives
- Cars
- Boilers
- Engines
- Pumps
- Compressors
- Hoisting Engines
- Electric Machines
- Tools
- Steam Shovels
- Derricks
- Orange Peel or Clam Shell Buckets.

M. K. FRANK

Frick Bldg. Pittsburgh, Pa.

New and Relaying Rails,
Spikes and Bolts
Second-Hand Mine Cars and Mining Equipment

Every reader will appreciate the great convenience, saying nothing of loss of time, which means money, in being able to receive **prompt shipment** on material, and in this light we wish to place ourselves before the coal operators as having in stock at most all times large quantities of New and Relaying Rails, Spikes, Bolts and Nuts, Splice and Angle Bars, Frogs and Switches, Turn-Tables, Portable Track, and all gauges of new and second-hand mine cars.

RAILS

The large tonnages at our centrally located warehouses makes no order too large for us to handle or too small to receive our careful and immediate attention. We are equipped for cutting rail for use as buck staves, in the building of coke ovens, furnaces and other general uses where rail is more serviceable and more economical than I beams. We also have facilities for straightening rail.

SPLICE AND ANGLE BARS, SPIKES, ETC.

We make a specialty of supplying mine spikes, bolts and nuts, splice and angle bars for all section rail, and splice bars made to fit odd or any sections.

FROGS AND SWITCHES

We are in position to furnish complete track equipment, and we always have in stock, for prompt shipment, large quantities of new and relaying outfits. We also control the output of the Hitchcock patent cast steel frog and will be pleased to send you catalogue upon request.

SCRAP IRON AND COPPER AND SECOND-HAND MACHINERY

If you have any scrap to dispose of at your plant and want any rail or equipment, advise us giving description of same, and we will make an exchange trade with you, giving you what you need for scrap and second-hand machinery.

Our complete stocks permit us to compete with all mills and factories handling our line, and on this basis we respectfully solicit your business and inquiries.

L. A. GREEN

Offices, First National Bank Building
PITTSBURGH, PA.

New and Used Rails and Machinery
Specialists in Mine Equipment

Rails

New and Relaying
Light and Heavy Sections.
Rails Cut to Length

One of our principal specialties for the past sixteen years has been new and relaying rails from 12 to 100 pound sections. We are in position to furnish almost any quantity of first-class relayers, subject to the most rigid inspection.

Due to the large tonnage of relaying rails we have sold we are in better position to judge quality than the average inspection bureau. We make no extra charge.

Switch and Frogs

Carried in Stock
Special Material
Built to Specification

Large numbers of coal companies have used our services, without cost, for the laying out, (on an economical basis), their yards, tipple and room turnouts.

Accessories

Splice Bars
Spikes, Bolts and Nuts
Track Tools

We manage to have for quick shipment at all times, splice bars for standard and odd section rails, punched for any drilling. Send an impression of the rail or a sample bar at our expense.

Machinery.

New and Second-Hand
Engines, Boilers
Pumps, Compressors
Electric Mining Machinery
and Locomotives
Motors, Dynamos
Iron and Woodworking
Machinery

Due to our large list of available machinery and equipment from the smallest article to the most up-to-date and expensive machinery, we are used as an exchange bureau. We may have in stock or on our list the very thing you so urgently desire, or a market for the machinery you wish to dispose of.

We only handle good usable equipment.

Contractors' Equipment

New and Second-Hand
Locomotive and Cars
Steam Shovels
Road Rollers
Stone Chushers
Concrete Mixers
Hoisting Machinery
Derricks, Buckets
Carts, Wagons, Etc.

In addition to the supplying of rails, machinery and equipment for the operating mine, we furnish equipment for the building of coal and coke plants from the sinking of the shaft to the complete equipping of the operating mine.

Pipe

New and Second-Hand

Supplies

For Mills, Mines and
Contractors

While we do not handle a complete line of supplies, we specialize on items that are most needed at the mine. The high grade and attractive prices are due to our volume of business in the specialties.

We offer you a service that is conscientious, effective and to your profit.

THE M. E. LAZARUS CO.

976-978 Rockefeller Building
Cleveland, Ohio

Buyers of Scrap Iron & Metals

Scrap Iron

For the past eighteen years, we have been making a specialty of buying scrap from coal mines. Some coal mines prefer selling their scrap, just as it runs, others prefer to sell it sorted. We buy either way. We buy coal mine scrap, just as it runs, and we take everything in the line of scrap iron, with the exception of whole boilers, turnings, borings, sheet iron, and cable. These items we exclude. We buy nothing but No. 1 coal mine scrap in this instance. We also buy mine car wheels, if loaded separately from the other materials, as well as mine axles, if loaded separately from other materials.

Metals

We make a specialty of buying copper, brass, lead, babbit, and drosses, in fact anything in the metal line that is accumulated around a coal mine. Write us at any time, whenever you have any metals for sale, whether it be a small lot, or a large one. We buy metals in lots from a barrel upwards. Our terms are spot cash, either sight draft against Bill of Lading, or New York draft, upon presentation of invoice.

We pay the best of prices.

Rails

We sell rails for relaying purposes. Let us know your wants, whether it is a five ton lot, or a carload lot. We also sell rails cut to sizes, for building purposes.

Best of references from coal mines.

Pipes

We sell or buy new and second hand pipe. Write us and give your wants.

Machinery

We sell or buy:

New and Second-hand Engines,
Boilers,
Pumps,
Compressors,
Electric Mining Machinery and Locomotives,
Motors,
Dynamos,
Iron and Woodworking Machinery.

Write Us for Prices Before Selling.

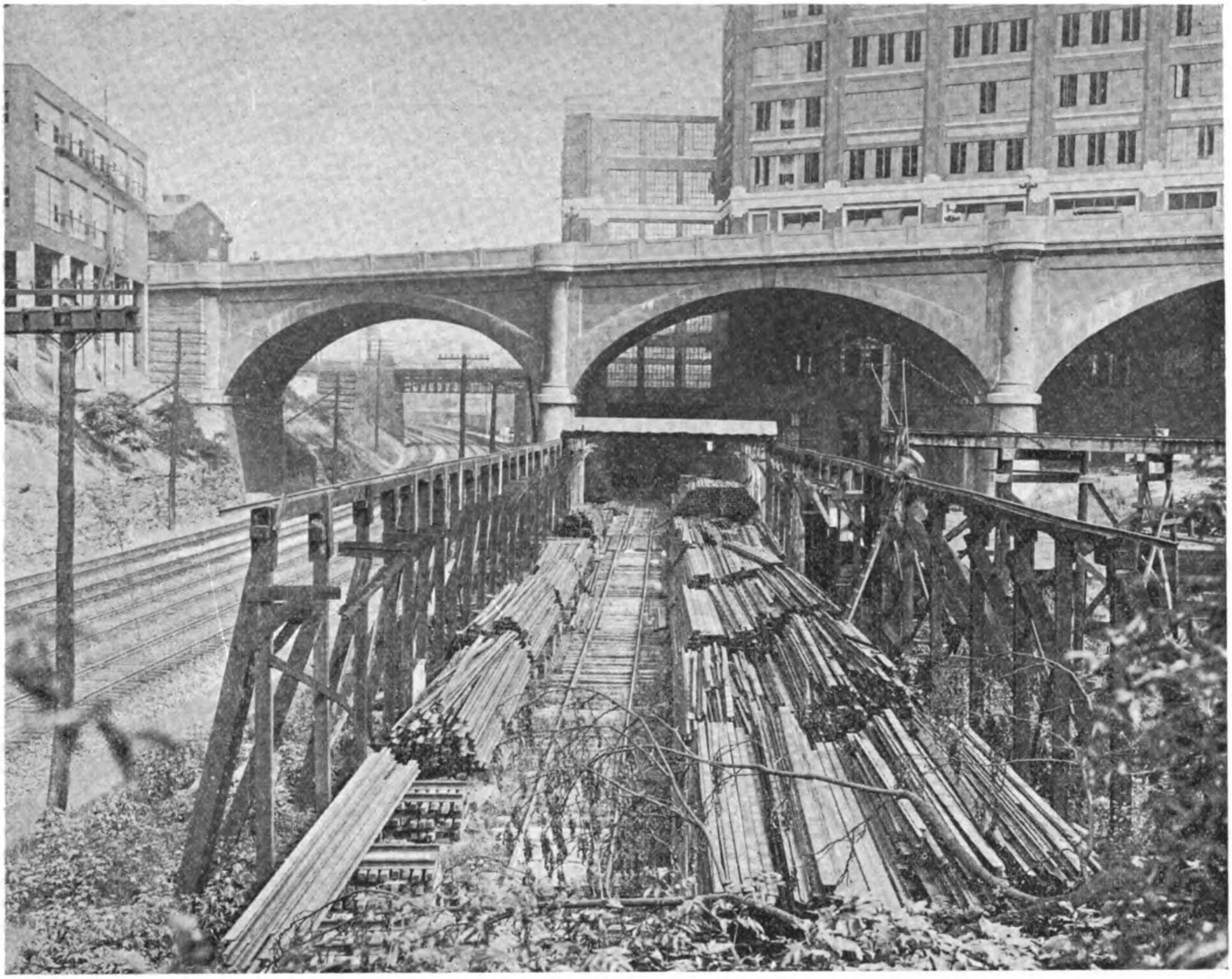
RICHARDSON & CO., INC.

1103 Bessemer Building
PITTSBURGH PA.

Cut Rails

RELAYING RAILS
NEW RAILS
SPLICE BARS
BOLTS
SPIKES
RAIL BRACES
TIE PLATES
FROGS & SWITCHES

We keep on hand standard sections second-hand Steel Rails to be cut in pieces of any length that may be ordered, for grate bars, furnace bottoms, supporters of water, gas and steam pipes, roof girders, posts and binders, and other uses too numerous to mention, that your wants will from time to time suggest. The use of these rails will save you 50%.



The Cincinnati Frog & Switch Company

General Office and Works CINCINNATI, OHIO

—Manufacturers of—

Track Equipment

for Steam and Electric Railroads, Mines and Mills

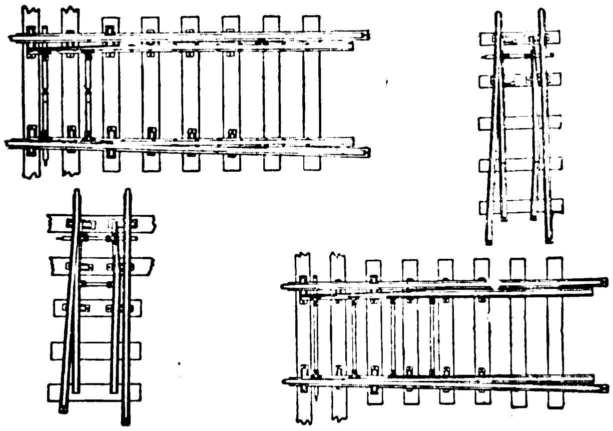
Products

Frogs, Crossings, Crossovers, Switches, Switch Stands, Guard Rails, Guard Rail Clamps, Rail Braces, Tipple Tracks, Tie Plates, Mine Turnouts, Portable Track, Steel Ties, Special Track work and Layouts of every description.

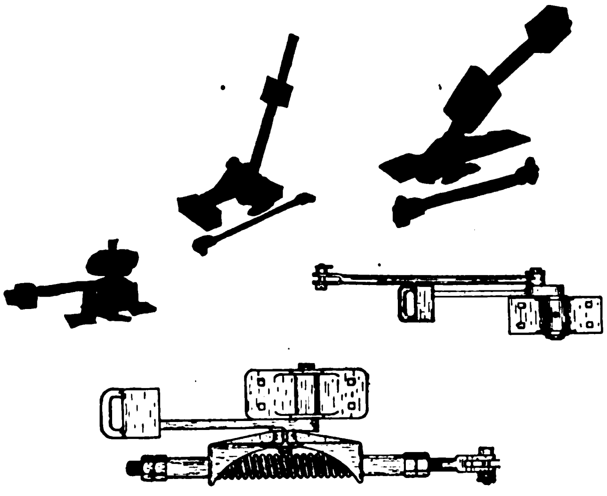
Specialty

We specialize in Track Equipment for Coal Mines, standard or special layouts.

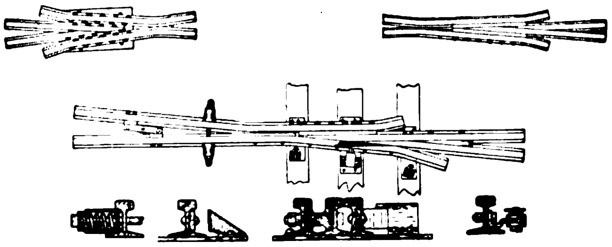
Our corps of expert engineers will solve your transportation problems. We make no charge for consulting engineering. Tell us your track troubles.



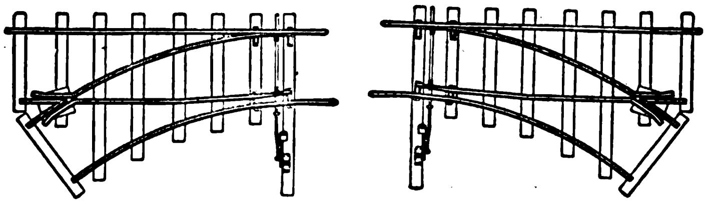
Split Switches.
We make over thirty-five types of switches.



Switch Stands.



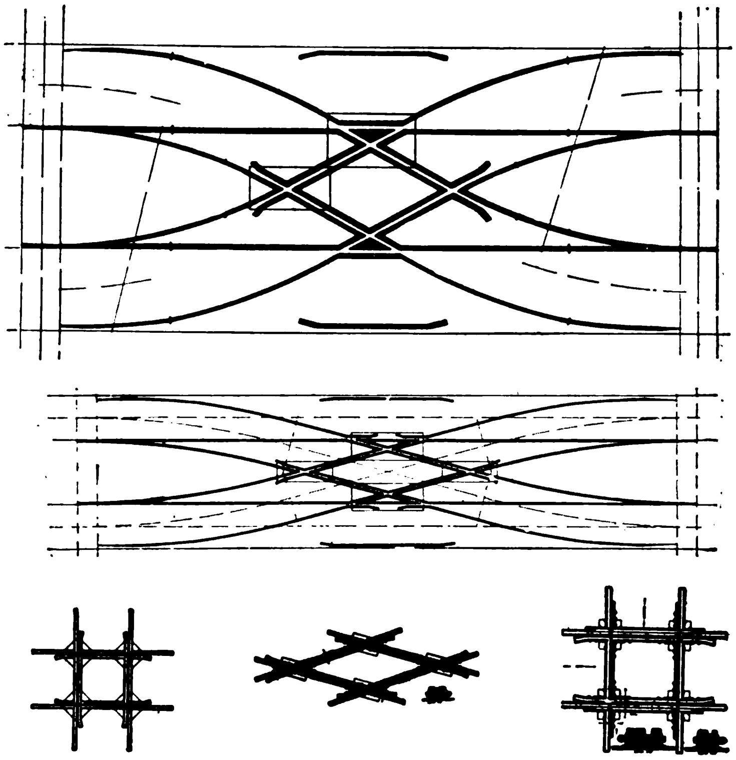
Stiff and Spring Frogs. Various types.



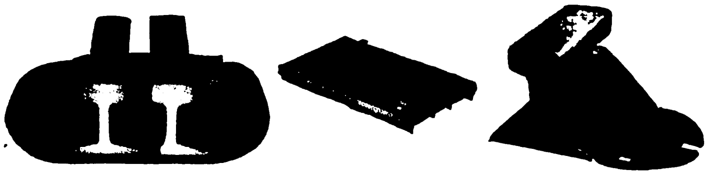
Curved Room Turnouts.

We have shipped thousands of these Curved Room Turnouts to mines and recommend their use on short radius curves.

Please notice that the Frog Arms are made long enough to abut the Switch, thus eliminating the short filling rails, also saving two pair of fishplates per turnout.



Crossings and Crossovers.



Adjustable Guard Rail Clamps, Tie Plates, and Rail Braces.

Deliveries and Facilities

Our plant is equipped with modern machinery and appliances; our workmen are experts. We carry an immense stock of raw material, and have excellent shipping facilities. Therefore, can furnish on short notice anything in the line of Track Equipment, either standard or special.

Ask for copy of our Catalog.

CLINTON SWITCH COMPANY

CLINTON, IND.

Manufacturers of

Clinton Latches and Para-lock Switch Throws

Products

We manufacture THE CLINTON LATCH to fit any weight rail from 16 pounds to 40 pounds, A.S.C.E. standard, in the following lengths:

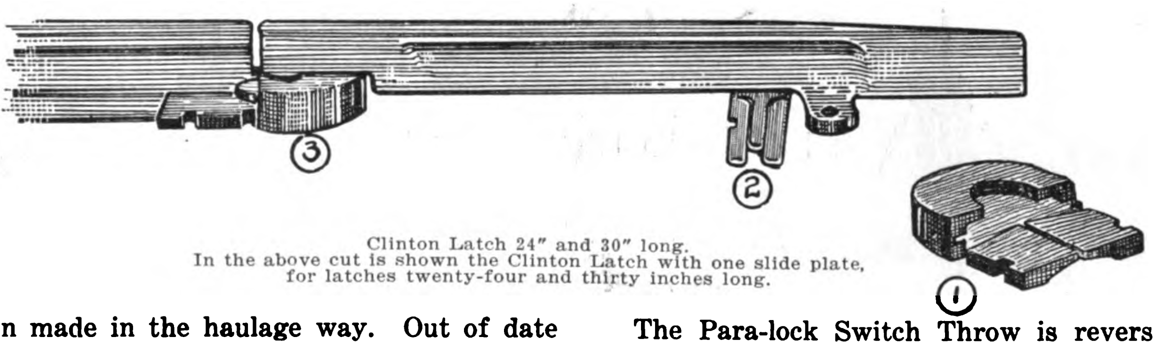
16-pound, 24 inches long; 20-pound, 24 inches, 30 inches and 36 inches long; 25-pound, 30 inches, 36 inches and 42 inches long; 30-pound, 30 inches, 36 inches and 42 inches long; 35-pound, 36 inches, 42 inches and 48 inches long; 40 pound, 42 inches, 48 inches and 60 inches long. Other sizes made to order on special quotations.

The CLINTON LATCH is packed in sets, each consisting of one right-hand point, one left-hand point, two base-plates and two to four side-plates, according to length of latch. We do not include bridle-bars, which are usually made from scrap bars, to suit track gauge.

The Clinton Latch (Patented)

To keep a modern mining operation up to its full capacity, every unit of the system must be as nearly perfect as possible in order to maintain the proper ratio between cost and tonnage. In order to produce the results expected of the mines of today, you have developed electric and gasoline locomotives, large pit-cars, automatic caging devices, coal cutting machines and other devices to increase tonnage or lower costs.

What about the tracks and switches? With the exception of heavier rail, little improvement has been made in the haulage way. Out of date switch point construction is still common. The heavy motors and large cars of today will not run right over the switches of yesterday.



Clinton Latch 24" and 30" long.
In the above cut is shown the Clinton Latch with one slide plate, for latches twenty-four and thirty inches long.

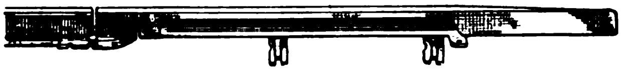
Rivets, bolts, strap iron or fish plates are not used in attaching The Clinton Latch to the switch rails. Thus we have eliminated the chief cause of latch trouble.

The flat, rounded base, or pivot lug on the butt-end of the latch, fits into and interlocks with the base-plate. The base-plate is undercut on the bottom to fit over the base of standard rail and slotted to receive the web. The base-plate has four spike notches for spiking to tie. This method of construction allows all necessary motion of the switch-points, but makes imperfect alignment impossible. The only chance for this latch to turn over is for the rail to turn with it. The slide-plate which is also notched for spikes, furnishes a good bearing for the point-end of latch.

In laying these latches the slide-plate should be placed inside of and close to the bridle lug of latch and not at the point. This gives a broader support for latch at the point where weight of car or motor actually falls on latch. The tire of wheel, being at least three inches in width, is supported by adjacent rail till well past the bridle lug.

The Para-Lock Switch Throw (Patented)

It throws parallel with the track and locks itself automatically at either extreme of lever movement, yet may be used as an automatic switch to outgoing motors when lever stands at middle positions. The safest switch throw made. Danger to motormen and switchers is reduced to a minimum by its use. Semaphore may be attached when desired.

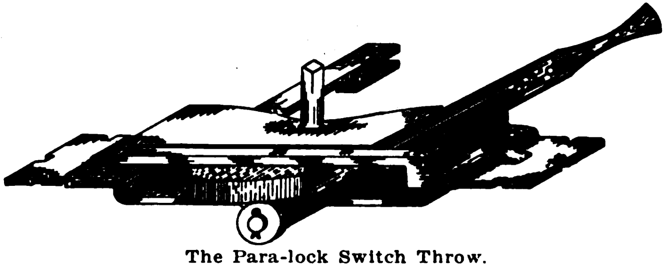


Clinton Latch 36" and longer.
Note the extra slide plate, so designed as to take care of both downward and lateral stresses.

It sets low and its pull is in direct line with bridle bar, while the throw itself is less liable to be damaged by derailed cars, etc., should such a thing occur. This last point, however, is not liable to be proven because a switch equipped with Clinton Latches and Para-lock Switch Throws stands little chance to cause a derailment.

We use the best malleable iron in our switch throws and they will stand all kinds of abuse.

The Para-lock Switch Throw is reversible by taking off top and inverting one part. Every Para-lock thus is either right or left as you desire.



The Para-lock Switch Throw.

If the cut does not show enough to convince you, let us send one on approval. The price is right.

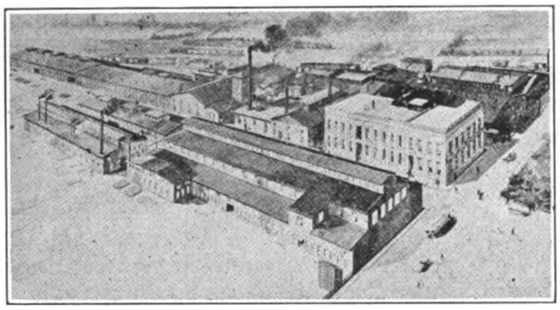
We are willing and anxious to allow you to try either The Clinton Latches or Para-lock Switch Throw for a long enough time to prove their value. In ordering latches sent on trial, specify length of latch and weight of rail used.

ELLIOT FROG & SWITCH CO.

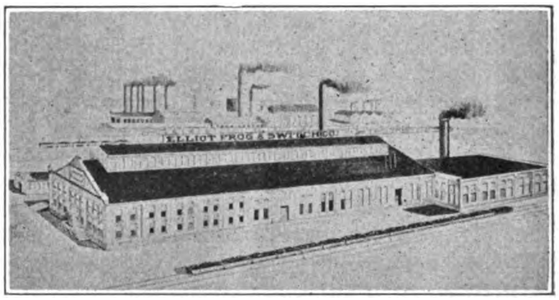
EAST ST. LOUIS, ILL. PUEBLO, COLO.

Manufacturers of

Frogs, Switches, Crossings and General Track Work Special Work for Mines and Smelters

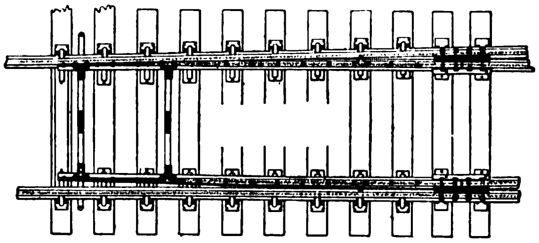


East St. Louis, Illinois Plant.

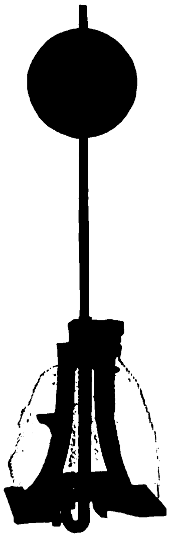


Pueblo, Colorado Plant.

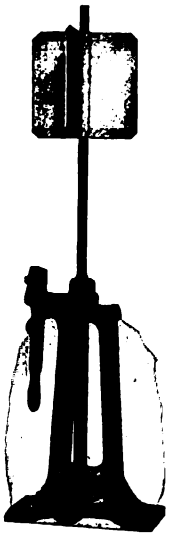
FROGS
SWITCHES
CROSSINGS

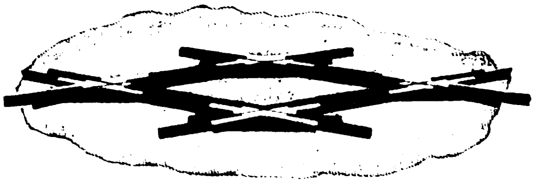


SWITCH STANDS
GUARD RAILS
CLAMPS

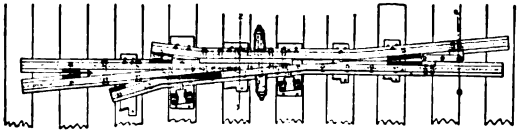


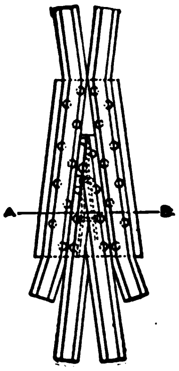
ELLIOT FROG & SWITCH CO.



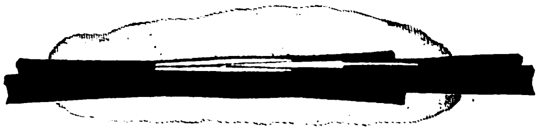


E. ST LOUIS, ILL — AND — PUEBLO, COLO.

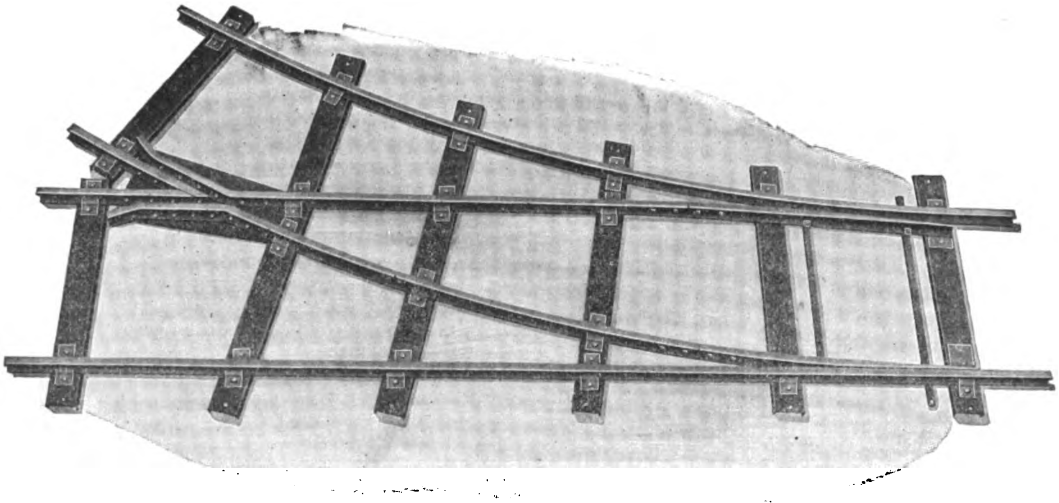


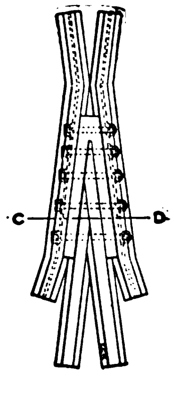


FOR STEAM AND
ELECTRIC
RAILWAYS



MANGANESE
CASTINGS





THE INDIANAPOLIS SWITCH & FROG CO.

General Offices and Works, SPRINGFIELD, O.

SALES OFFICES:—NEW YORK, CHICAGO, PORTLAND, ORE., LOS ANGELES, SAN FRANCISCO,
KANSAS CITY, SPOKANE, SEATTLE.

Products.

Frogs, Switches, Crossings, Stands, Rail Braces and all track accessories for Rails from 8 to 100 lbs. per yard.

Service.

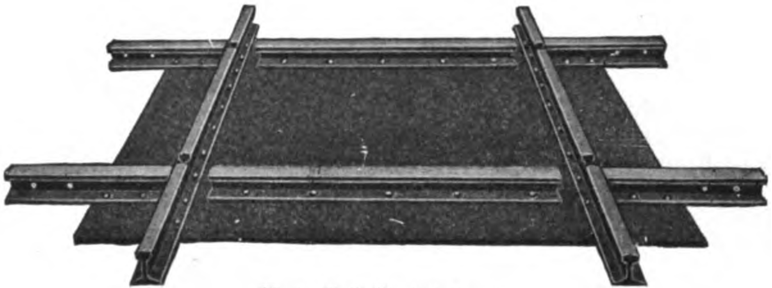
We design your layouts and make no charge for consulting engineering. Our facilities for making prompt shipments are of the best.

Quality Counts.

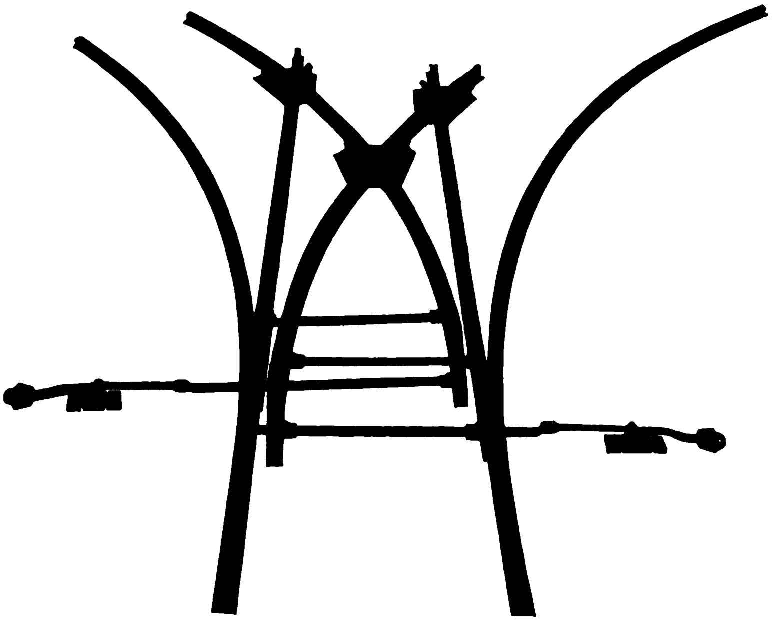
Cheap track layouts are false economy. Layouts scientifically and correctly designed and of the best material and workmanship last longer, save motive power, prevent derailments, breakdowns, damage and delay, and require less for up-keep.

Catalogue.

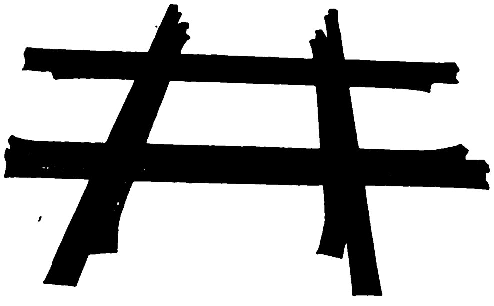
We have a large bound catalogue showing detailed descriptions of our product which will be sent upon application.



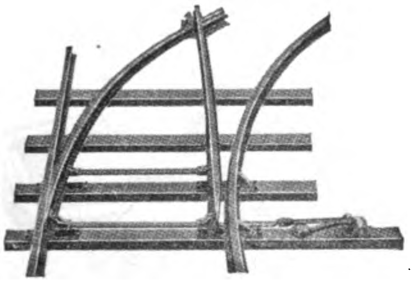
Single Rail Riveted Crossing.



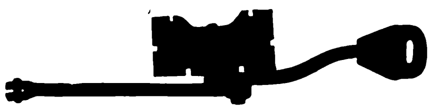
Three-Way Switch with Ground Throw Stand.



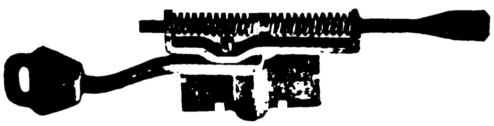
Bolted and Filled Crossing.



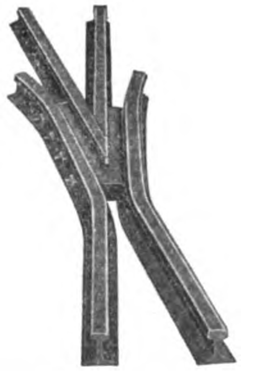
Combination Switch and Frog for Short Radius with Ground Throw Stand.



Plain Ground Throw Stand.



Spring Ground Throw Stand.



Rigid Bolted and Cast Filled Frog.

KILBY FROG & SWITCH COMPANY

BIRMINGHAM, ALABAMA

Manufacturers of

Railroad Crossings, Frogs and Switches, Etc., for Steam, Electric and Industrial Railways

---

Frogs.

We manufacture frogs of any description including Spring, Pivoted tongue, Riveted plate, Steel or Cast filled bolted, Manganese Insert and Solid Manganese frogs.

Switches.

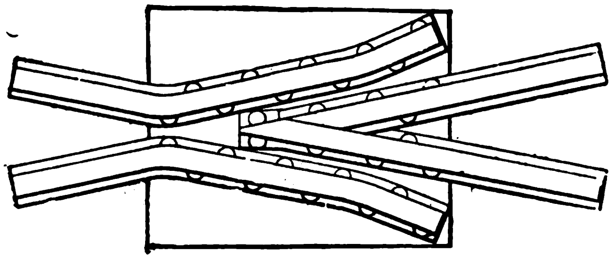
Of any desired type — plain or reinforced Switches, Curved Turnouts with frog arms connecting with the Switch, Room Switches and portable track of all kinds.

Switch Stands.

Low and high target Stands, Ground throws for light or heavy switches.

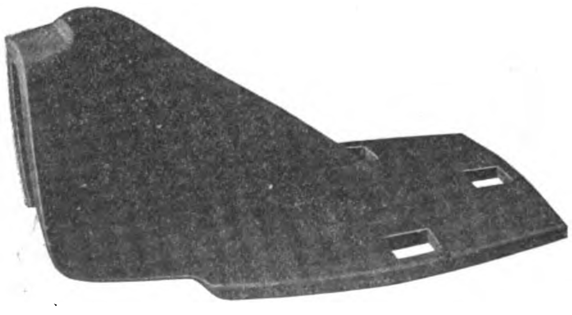
Crossings.

Of Single rail, two rail or three rail type — with or without riveted plates, Ordinary rail construction, also Manganese Insert and Solid Manganese Crossings.



Design No. 54.
Light "T" Rail frogs on riveted plate.

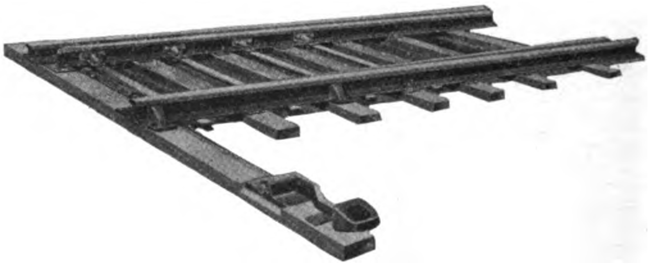
Design No. 133.
Standard Split Switches.



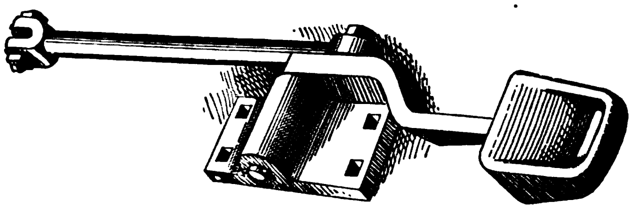
Design No. 202.
Pressed Steel Rail Braces.

Design No. 55.
Rigid Steel filled frog.
Can be furnished with or without plate.

Design No. 76.
Rigid Cast filled frog with or without plate.



Design No. 102.
Split switch with Spring Ground Throw.



Design No. 180.
Ground Throw for heavy switches. These are also made in a lighter design for light switches.

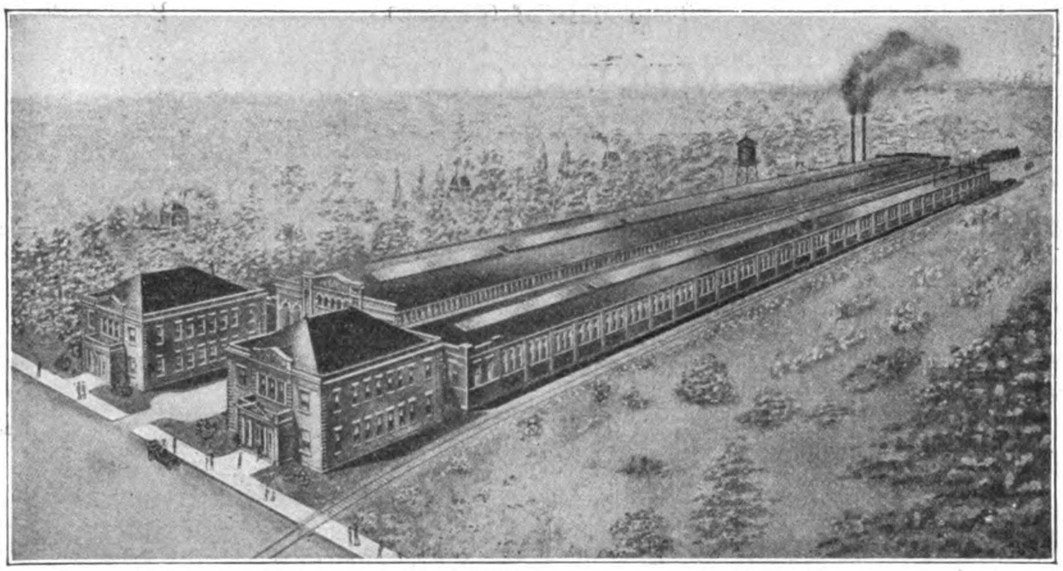
Established 1882

WEIR FROG COMPANY

CINCINNATI, OHIO

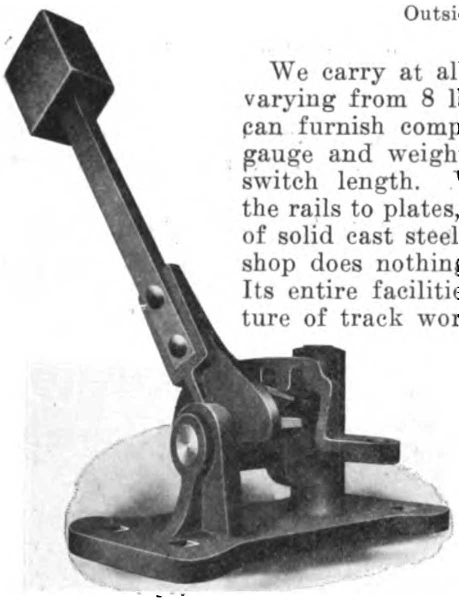
Manufacturers of Frogs, Switches, Crossings, Stands, Braces, Etc.

OUR SHOP MADE TRACK WORK IS MORE DURABLE AND CHEAPER IN THE LONG RUN THAN YOUR BLACKSMITH MADE FROGS AND SWITCHES GOOD FIT GUARANTEED.



Outside View of Shop Located at East Norwood, Ohio

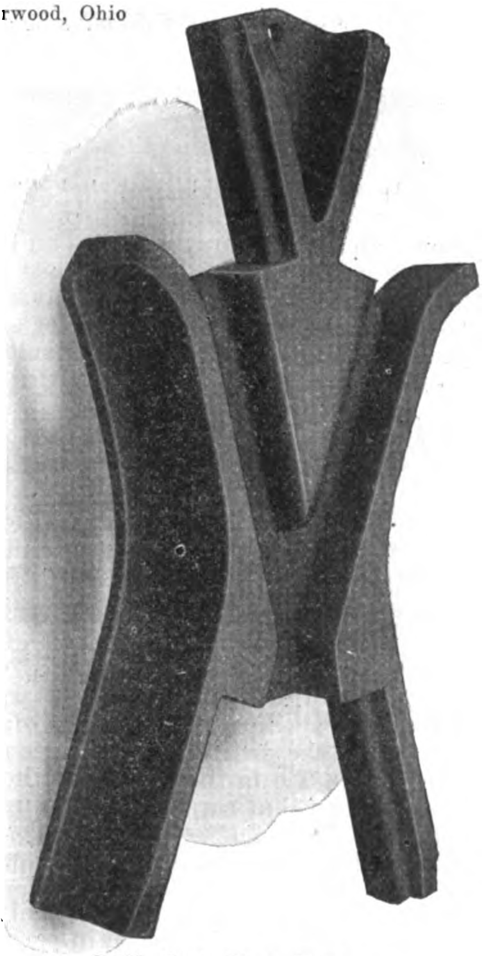
We carry at all times a stock of light rails varying from 8 lbs. to 40 lbs. and over. We can furnish complete turnouts of any radius, gauge and weight of rail; any frog angle or switch length. We make frogs by riveting the rails to plates, by bolting the rails together, of solid cast steel or of manganese steel. Our shop does nothing but frog and switch work. Its entire facilities are given to the manufacture of track work.



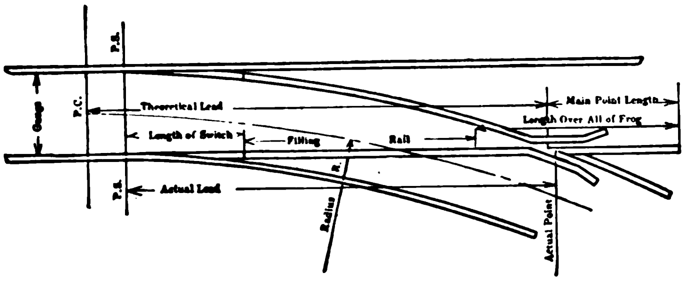
Malleable Iron Ground Throw—Throws Parallel to Track

This frog made without plates or rivets. It is made to fit angle and rails.

Low priced and durable.



Solid Cast Steel Frog



R. H. Turnout Showing Dimensions Required to Make Work

WRITE FOR CATALOGUE "C" GIVING TABLE OF TURNOUTS.

FAIRMONT MINING MACHINERY CO.

Regular Equipment.

Tipple Structures
Screens and Chutes
Loading Booms
Picking Tables
Conveyors—all types
Cable Car Hauls
Chain Car Hauls

General Offices and Works

FAIRMONT, W. VA.

TRADE MARK REGISTERED
FAIRMONT
101-20
(The Mark of Quality.)

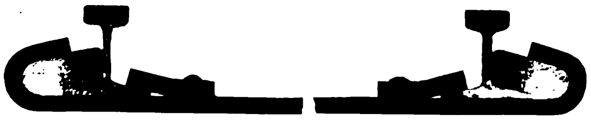
Specialties

Steel Mine Ties
R. R. Car Retarders
Portable—
Electric Mine Pumps
Power Coal Augers
Box Car Trucks
Mine Car Trucks

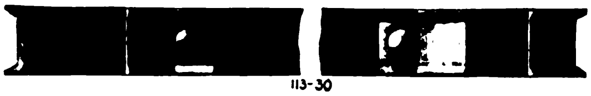
COAL MINE EQUIPMENTS

Fairmont Steel Mine Ties

Fairmont Steel Mine Ties are made of a special Channel Section 2″ wide, 9/16″ high and 3/16″ thick in web (which is heavier in thickness than any steel tie on the market), with gauge clip of same section riveted on tight and ends bent up and over (bent cold) for wedge. This section gives exceptional stiffness for the size and makes a tie that stands up under most severe conditions for rooms and cross entry work. The thinnest part of the tie is 3/16″ thick and will last for years. We have reports from ties that have been in mines where the worst of sulphur water exists for 3 to 5 years with apparently no bad results on ties.

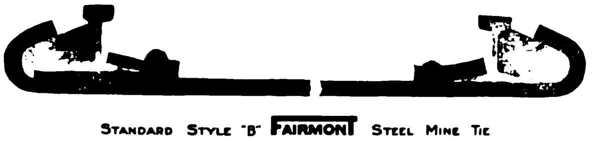


Standard Style "A" FAIRMONT Steel Mine Tie

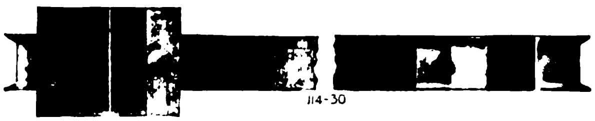


113-30

The best and most widely used Steel Mine Tie ever made. More than half million in use today.



Standard Style "B" FAIRMONT Steel Mine Tie



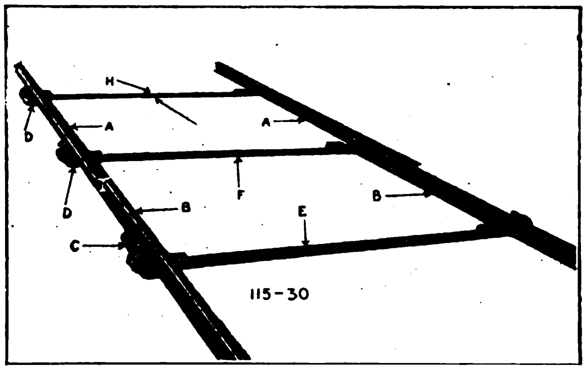
114-30

Joint Tie for extreme conditions. Has base plate and clip 4″ wide on one end.

The Jumper Feature

One of the greatest advantages of the Fairmont Steel Mine Tie is the simple method of advancing the track so that cars can be run up to the face for loading. This feature alone makes the Fairmont Tie worth more, in any mine, than the whole cost of the tie.

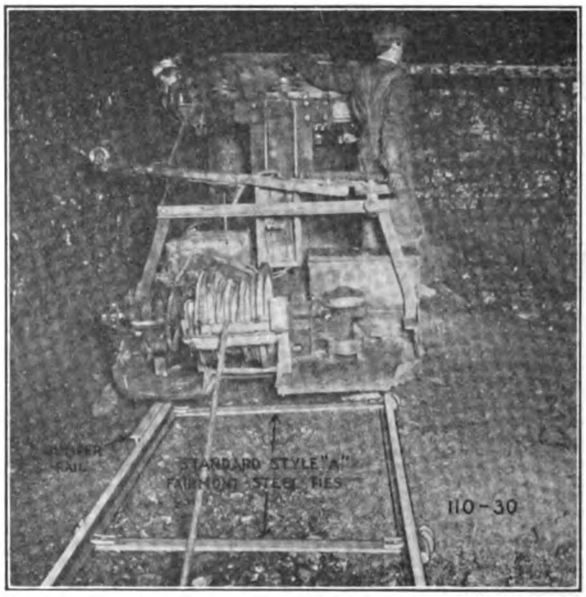
In the illustration "A" is rail turned upside-down as jumper; "B" is rail in permanent position; "C" is wooden wedge (Split out of old lumber or props) for holding rail firmly in place; "D" wedges along jumper rail; "E", "F" and "H" are standard style "A" ties showing rails jointed at end without splice plates; the joints are broken and jumper on right hand side is advanced almost to point for turning up in permanent position while on the left is just starting in.



A Section of track laid with Fairmont Standard Style "A" Steel Ties showing method of advancing track with Jumper Rail.

Other Advantages of the Fairmont Tie

They hold tracks true to gage, and the rail resting on the floor between the ties makes a solid track.

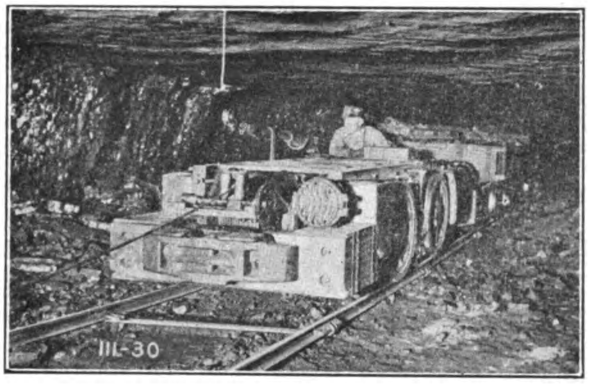


1-Ton Turret Mining Machine on Fairmont Steel Mine Tie Track—one side on Jumper Rail.

FAIRMONT

Steel Mine Ties

FAIRMONT



Gathering Motor on Fairmont Steel Tie Track.

They bring the track right down to the floor (the rail resting on the floor between ties) which makes it easier to load cars, and in low coal saves up three or four inches of bottom or this much roof.

No splice bars, bolts or spikes required in laying the track. On tracks where heavy cars and gathering motors are used, we recommend Style B ties at all rail joints.

The cost is less than wood—we can prove it.

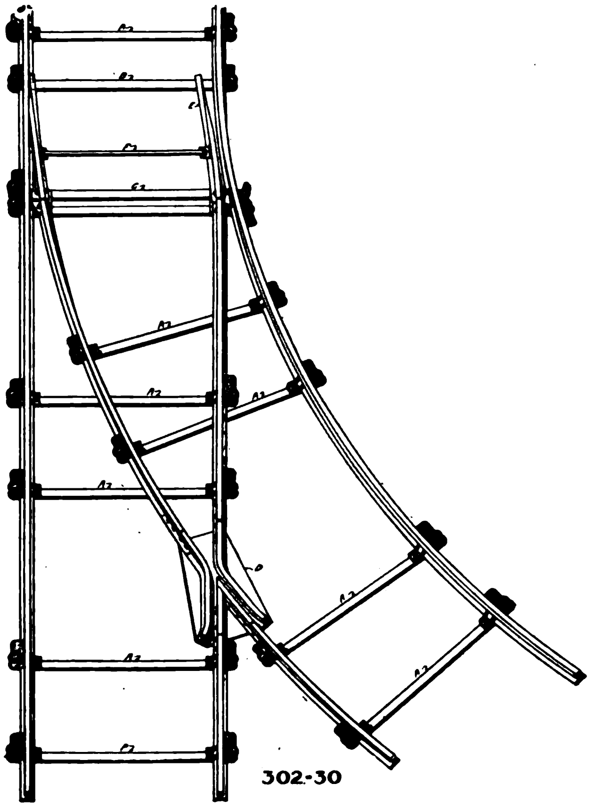
More coal is loaded on cars on account of having more height.

Loaders lay their own tracks.

Less cost to handle steel ties.

Less lift to put cars back on track.

No track gage or other tools needed for laying up tracks.



Only one-third as many steel ties required as wood.

Can be used for years.

Standard tie for 20-pound rail can also be used with 12-pound and 16-pound steel, and tie for 35-pound rail is good for 25- and 30-pound, which is quite an advantage where there is more than one size rail in use.

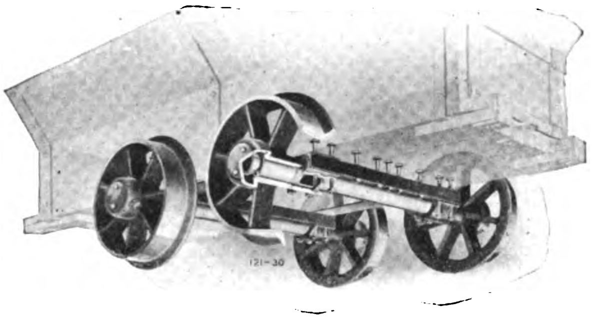
Ties bent in wrecks are easily straightened.

Turnout Ties

Our turnout ties are of the same section as the standard A and B style ties with only the changes in chape necessary to take care of curvature, etc. They have the same advantages as the straight ties, with the added advantage of simplifying the turnout question. To put in a turnout it is only necessary to secure an ordinary frog, have the blacksmith make a couple of short switch points, and our switch and track tie does the rest. Let us send you one of our Bulletins describing fully our line of Steel mine ties.

The Fairmont Hollow-Axle Truck

In this truck the axles are hollow—being made of seamless steel tubing with walls approximately one-half inch thick. This forms a lubricating reservoir, and has a capacity sufficient to lubricate the wheel for three to five thousand miles. The axle is supported by bearings which are bolted to the car bottom and in operation will creep and turn slightly in these bearings, equalizing the wear. There can be no leakage of lubricant when the car is standing still, and only sufficient when the car is running to lubricate the surfaces of the wheel and bearing when side thrust strains are taken.



With the lubricant within the hollow axle there is no tendency for the grease to be thrown outward away from the bearing when in motion. The lubricant is within the bearing and feeds on them equally and constantly at all speeds and on any length run.

The strength of the tubular axle is approximately double that of the solid axle of the same weight. To minimize the ware, the ends of the axles are case hardened, and ground to size.

The wheel itself is practically without reservoir, etc., hence it is simpler, lighter and stronger than any other wheel on the market.

LIGHT RAILWAY EQUIPMENT CO.

General Offices
Commercial Trust Bldg.
PHILADELPHIA, PA.

Works,
Chester, Pa.

Branch Office,
1116 House Bldg., Pittsburgh, Pa.

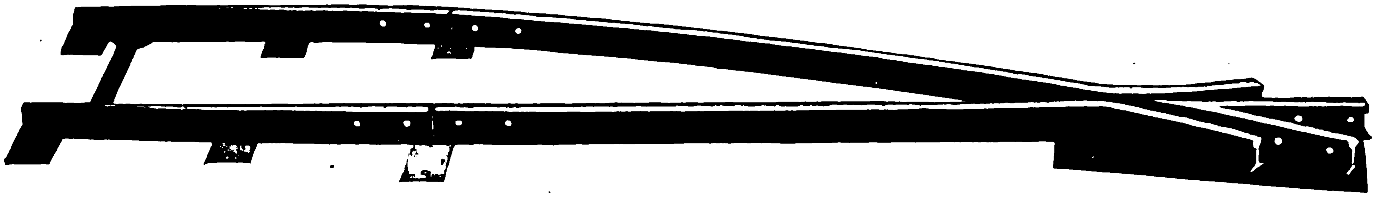
Manufacturers, Engineers and Contractors

Products

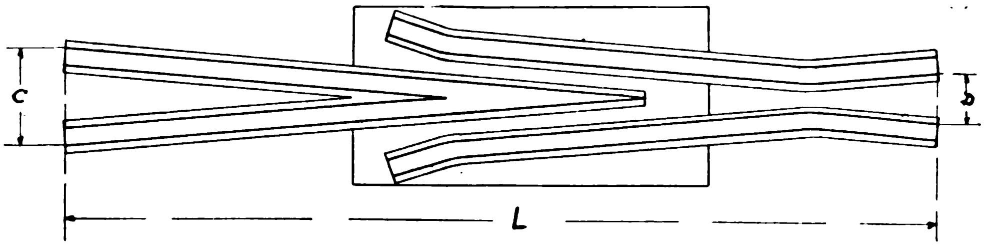
Portable Railways; Narrow Gauge Railways; Industrial Electric Railways; Cable Railways; Electric Locomotives, Over Head Wire, Third Rail, Storage Battery.

Switches; Frogs; Crossings; Ground Throws; Rails; Rail Joints; Spikes; Track Bolts; Turntables; Cars, Etc.

Track material drilled and supplied with bonds when desired.



This type particularly adapted for use in rooms. When ordering specify radius, weight of rail and gauge.



When ordering Frogs state weight of rail, length and number of frog.
To find the number of a frog, divide the length L. by C. and D.

The following in stock for prompt shipment:

FROGS

Wt. of Rail	No.	Length	C	D
20 lb.	2	3′0″	12″	6″
20 "	3	3′0″	8″	4″
20 "	4	4′0″	8″	4″
30 "	3	3′6″	9¼″	4⅝″
30 "	4	4′0″	8″	4″
30 "	5	5′0″	8″	4″
40 "	3	3′6″	9¼″	4⅝″
40 "	4	4′0″	8″	4″
40 "	5	5′0″	8″	4″

SWITCH POINTS

Wt. of Rail	Length	Number of Tie Bars	Number of Plates
20 lb.	4′0″	1	4
20 "	5′0″	1	4
30 "	4′0″	1	4
30 "	5′0″	1	4
40 "	5′0″	1	4
40 "	6′0″	1	6
40 "	7′6″	2	6

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

MINE CAR SECTION

Treatise
and
Engineering Data

Mine Car Specifications

The following manufacturers have catalogue descriptions in this section:

American Car & Foundry Co.
Duncan Fdry. & Machine Co.
Enterprise Foundry & Mch. Works.
Gustafson Mfg. Co.
Hockensmith Wheel & Mine Car.
Hyatt Roller Bearing Co.
Irwin Mine Car & Fdry Co.
Kanawha Mfg. Co.
Lobdell Car Wheel Co.
Macomber & Whyte Rope Co.
McKay, James Co.
Ottumwa Iron Works, Inc.
Phillips Mine & Mill Supply Co.
Pittsburgh Knife & Forge Co.
Pressed Steel Car Co.
Sanford-Day Iron Works.
Star Mfg. Co.
Watt Mining Car Wheel Co.
Youngstown Steel Car Co.

For additional descriptions of Mine Cars and Equipment, not appearing in this section, refer to Index of Products in front of book.

MINE CARS

By E. N. Zern, E. M.*

The car is the universally adopted medium for conveying the coal from the working places to the surface. As might be expected, owing to the multitudinous conditions encountered in mining, cars vary greatly in construction and in details. Height of seam, bad top, heaving bottom, quality and use of coal, methods of payment for coal loaded, dimensions of shaft, etc., all exercise an influence on car design.

Before a definite selection of equipment is made every consideration should be given to the many aspects having a most important economic bearing on the successful working of the property. The size of the car, its dimensions, its shape, the materials entering into its construction, kind of wheel, bearing, axle, the choice between a tight end and an open end car, lubrication, etc., all have an influence on the selection of a proper car.

With mine cars, as in track work, we can find much to sustain the charge that no standardization is in evidence. The head of one important manufacturing concern states that they have in their shop-files over 2000 drawings of mine cars of different patents and varying in size and dimensions. The statement is further made that they never yet, in their experience, have built identically the same car for any two companies.† Other concerns, being heard from, would make the situation still more astounding. This causes one to wonder whether there is great dissimilarity between all mines operating in the same seam in a given locality. Ample testimony to the contrary can be had. While it is admitted that a car of given size and shape may not be suitable to each of two mines operating in different seams and under different mining conditions, yet the fact remains that in many localities (the Fairmont-Clarksburg region of West Virginia for instance) the same general type of car prevails though there is a wide variation in dimensions and details. Uniformity of conditions here, as frequently elsewhere, are favorable to standardization. If one corporation can adopt a standard car for all its mines, as is sometimes done, it may be construed as an argument that neighboring mines might possibly use a wagon identically the same.

In this section there will be discussed in a general way the principles which govern the selection of the many details which enter into the construction of a complete mine car.

Historical

The carrying of coal in sacks has already been mentioned as the earliest recorded means of conveyance.‡ An improved mode of movement was by tubs, or corves. Boys and women were engaged in the work of conveying the coal from the face to the shaft. They crept on their feet and one hand, dragging the tub along with the other hand—an extremely arduous task. "Women were dressed as boys, in trousers, crawling on all fours, with belts round their waists and chains passing between their legs.§

Female labor continued until 1842 when to the chargin of many of the operators, who freely predicted the ruination of the industry, their employment underground was prohibited by an act of Parliament. With the advent of metal rails, tubs gave way to wagons fitted with four wheels and which served as the prototype of our modern mine car.

Materials of Construction

Mine cars are built of wood and steel. Cars built of steel with wood replacing some of the steel parts are known as composite types.

Wood

White oak is chiefly used, the bottom boards being usually 3" thick, the side, flare, door, and end boards 1½" thick. There is considerable deviation from these dimensions, bottom boards alone varying from 2" to 4". The attractiveness of the wooden car lies in its cheapness, lack of stiffness in riding, and the ease with which repairs can be made using unskilled labor. In many localities where lumber and labor is cheap, wooden cars are built in the mine shops, the iron parts, trucks, etc., being supplied by the manufacturer.

Steel

The superiority of the steel car is being generally recognized and it is gradually supplanting wood. Its advantages are: (1) with the same dimensions as a wood car it will hold 10% to 20% more coal, or, in low seams, it may be cut down 4" to 6" in height and hold the same amount. In this latter event it; (2) requires less muscular effort to load; (3) the cost of maintenance is less; (4) it withstands shocks and survives wrecks that would smash a wooden car; (5) owing to its stiffness it does not droop at the ends like a wooden car; (6) it makes a tighter car and minimizes the loss of fine coal in transit.

Balanced against these desirable features are its higher cost, about 40% more than a wood car; its lack of flexibility in riding; corrosion of the steel; the difficulty in making repairs and the skilled labor required in such work.

The steel plates used for the sides may be in one piece bent to the shape of the car, or in sections fastened together with bolts or rivets. The object in the use of bolts is to facilitate the detachment of any damaged portion and the subsequent replacement after straightening. When rivets are used a damaged car is straightened by heating with blow torches and hammering, or else by the use of rail benders and jacks. At some mines a crib or cage of ties is built, just large enough to admit a car which is straightened by means of jacks placed between the crib and the car, and acting in opposite directions. Often, even when the straightening has been carefully done, trouble is had with the

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*Head of Mining Department, West Virginia University.
†Coal Age, Vol. 8, pg. 24.
‡See Mine Track Section.
§Report of Royal Commission.

closing of the end gate, since the alinement is never quite the same as before the accident. Here it may be observed that tight end cars offer an undoubted advantage since any imperfection in alinement would not be noticed with a rotary dump.

Composite Cars

The use of steel bottoms has, in many instances, been found objectionable owing to the rapid corrosion which sets in, and which is here more noticeable than on the sides. In place of steel, therefore, wood may be specified. Such a composite type costs less than the all-steel car, though 25% to 30% more than a wood car. Besides increasing the durability of the bottom, it is less stiff and rigid than the all-steel car, and usually less expensive to keep in repair.

Size of Mine Cars

The American mine car greatly exceeds in size that used in England and Continental Europe, where, owing to the working of thin seams, the dimensions of the car are necessarily restricted. Many of the cars in use hold as little as 800 pounds of coal, the preferable size carrying 12 to 14 cwts. This compares with the large cars found in the anthracite regions, and even in the bituminous fields, where cars holding as much as 8000 pounds are used.

It has already been stated in the discussion of Mine Tracks that the thickness of the seam limits the height of the car; the width of the entry, dependent upon the condition of top and bottom, limits its width, while the allowable wheel base governs the length. Given a low seam with good top a car of great breadth may be used, but here we are confronted with a difficulty in construction, i. e., making strong the sides of the car overhanging the wheels. Increasing the gage decreases the overhang but this involves an additional money outlay in track construction. Greater length of car may be attained by increasing the wheel base beyond 28″ or 32″, as generally found, but the hesitation here is due to the difficulty in replacing derailed cars, and the large radii necessary to provide a smooth movement between tangents.

The remaining variable is the height of car. In general practice this is directly proportional to the height of the seam, cars used in the Pittsburg seam running as high as 52″ above the rail, while in the low seams cars half this height are used. While conditions will be such that there is little choice to the height of car in low seams, the question may well be asked, what is the desirable height in a thick seam?

In seeking an answer, increasing consideration is being given by engineers to the researches of men like Poncelett, Morin, Rankine, Taylor, and others, who have conducted careful investigations to determine the muscular energy of men. The data here given is of interest to the loading of coal:

Nature of Work.	Weight Moved or Resistance Overcome In Pounds.	Velocity of Movement, Ft. Per Sec.	Work Done Per Sec. Ft.—Lbs.	Time of Working, Hours Per Day	Work Done Per Day Ft.—Lbs.
Shoveling Up Earth; Lift 5 Ft., 3 in.	6	1.3	7.8	10	280,800

"The work of Dr. F. W. Taylor shows that a maximum amount of shoveling may be accomplished by the use of a shovel taking up a load of 22 lbs.; also that by the introduction of rest periods at stated intervals (determined from a study of the particular task) the amount of work done in a day by a laborer may be greatly increased over the figure given."*

Accepting the figure given, 280,800, as the work in foot pounds possible to be done per day, let us apply this to the task of loading coal into two cars having heights of 52″ and 32″ respectively above the rails, adding 6″ in both cases for clearance. The number of pounds of coal shoveled in the first instance in a day of ten hours would be 280,800÷4.833 feet=58,100 lbs., or about 29 tons. In the case of the low car we have 280,800÷3.167 feet=88,664 lbs., or about 44 tons. The meaning of this then is that with the low car, the average man can load 44 tons of coal per day with the same muscular effort as required to load 29 tons into the high car. The difference, of 15 tons, represents the disadvantage to both mine owner and coal loader in having a car of excessive height. The fact that the tonnage figures mentioned are not reached in the mine does not alter the percentage in favor of the low car. That the advantage in their favor is not fanciful is indicated by the specifications of several large producers, who, with the privileges accruing from mining a thick seam, yet stipulate that the height of car top above the rail shall not exceed 32 inches. As might be reasonably expected, their experience has shown that the laborer realizes the advantage of the lower car and will willingly load more coal in a lower car at the same price than they will in a higher one. In addition there is less breakage to the coal, a point of considerable importance in most localities. With low cars equilibrim is more stable as the center of gravity is low.

Assuming then the selection of a low car, a large capacity can be obtained only by increasing the length and the breadth. If the inside length of the car be extended to 10 feet, which would appear to be a desirable maximum owing to the throw of the coal in loading, the wheel base will also need to be increased. In some mines this now amounts to 48 inches. With such a length not only are easy curves necessary, but, moreover, every precaution must be taken to keep the track and rolling stock in good repair so that derailments will be few. The maximum breadth to a car, assuming favorable external conditions, would appear to be about 6′-6″, the overhang with a 48″ gage being about 16 inches. A car with the following dimensions, 10 feet inside length, 6′-6″ in breadth, and 32″ in heighth above the rail would have a capacity of about 100 cubic feet, or 2½ tons of coal level full. By careful topping an extra ton could be added.

A division of opinion exists respecting the merits of large mine cars. Those opposed point to the excessive weight, the loss of time when derailments occur, the difficulty men have in placing them to the face, the need of heavier rails, ties, spikes, etc., and the higher initial cost. Those, contrary-minded, bring forth proof to show that even though the large unit is heavier, the improvement in wheels, axles and bearings makes it easier running than the light cars of yester year, that derailments are due to carelessness in construction and maintenance of tracks and can be largely avoided, that in most mines cars are hauled to the working places by animal or mechanical power, and that the higher initial investment is more than offset by the increased daily tonnage. It is beyond question that in many of the details connected with the delivery of the car from the working place to the tipple, and its return, the same time and effort is required with the small car as with the large. A survey of the field indicates that the trend is toward the larger car, the probable limit being from 3 to 4 tons of coal carried.

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*See Mark's Mechanical Engineers' Handbook, pg. 863.

It is plainly true that the car which shows the greatest ratio of useful weight (coal carried) to tare (car weight) will be the most economical in power used, everything else being equal. *Kerr states that a "tub to hold 10 to 12 cwts. should not weigh more than 4 cwts., if constructed of wood, or 5 cwts., if of iron." The ratio here on a basis of 100 pounds is about 72 to 28, and refers to small cars. The statement has many times been made that large cars show a more favorable ratio in this respect than small ones, a statement hardly borne out in practice.

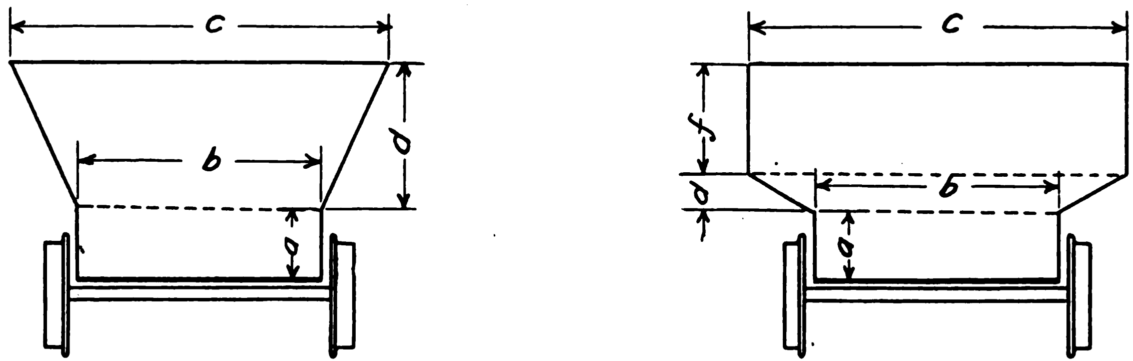
The table following shows the ratio obtaining between cars of light weight, medium weight, and heavy weight. All of the figures on light cars, and the first two given under medium weight are taken from Bulletins of the Illinois Coal Mining Investigation by S. O. Andros. The tare on the remaining cars has been given by the manufacturers; the weight of coal has been either figured from the cubical contents, or from capacities as given by the manufacturer, with an allowance of 20% for topping. This allowance is, in many cases, insufficient since cars of 77 cubic feet capacity, rated at 2 tons, are sometimes loaded with from 3 to 3½ tons of coal, and cars rated at 1¼ ton may by careful topping be loaded to 2 tons. While the ratios in the case of medium and heavy weight cars are, therefore, in all probability too low, it will nevertheless be seen, after making allowances, that no great difference exists.

The failure of the large cars to show any advantage is due to the use of steel in place of the lighter wood, the use of heavier wheels and axles, draft gear, etc., all of which add greatly to the dead weight carried.

Tare.	Capacity of Cars In Lbs.	Ratio Of Coal To Tare.
	Light Cars	
800	2000	72—28
900	3000	77—23
1000	4200	80—20
1100	2600	70—30
1200	2600	68—32
1300	4200	76—24
1400	3000	68—32
1500	3500	70—30
1600	3000	65—35
1700	5000	75—25
1750	5600	76—24
1900	4000	68—32
2000	5000	72—28
Average ratio................		72—28
	Medium Cars	
2200	6000	73—27
2400	6000	71—29
2525	4000	61—39
2665	4800	64—36
2850	4800	63—37
Average ratio................		66—34
	Heavy Cars	
3240	6500	67—33
3330	6000	65—35
3500	6500	65—35
3700	8000	68—32
3780	6750	64—36
Average ratio................		66—34

How to Figure the Capacity of a Mine Car

The prevailing cars in the bituminous mines are either of the single flare or double flare type as shown in Figure 1.



Single Flare.

Fig. 1. Types of Mine Cars.

Double Flare.

The first step is to find the cross sectional area. Assuming first the car with a single flare, the area can be divided into two parts as shown by the dotted line, the lower part having the form of a rectangle and the upper part that of a trapezoid. All dimensions are to be given in feet.

The area of the rectangle $= a \times b$

The area of the trapezoid $= \frac{b+c}{2} \times d$

Total area of cross section $= (a \times b) + \left(\frac{b+c}{2} \times d\right)$

Multiplying this expression by L, the inside length of the car, in feet, we have,

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*Practical Coal Mining, pg. 226.

$$\text{Cubical contents}=L\left[(a \times b)+\left(\frac{b+c}{2} \times d\right)\right]$$

In the case of the double flare car we have a cross section made up of two rectangles with a trapezoid between.

Area of bottom rectangle $= a \times b$

Area of trapezoid $= \frac{b+c}{2} \times d$

Area of top rectangle $= c \times f$

Total area of cross section $=$

$$(a \times b)+\left(\frac{b+c}{2} \times d\right)+(c \times f)$$

Multiplying this expression, as before, by L, the inside length, we have,

$$\text{Cubical contents}=L\left[(a \times b)+\left(\frac{b+c}{2} \times d\right)+(c \times f)\right]$$

To find the number of pounds in the car when struck level, multiply the cubical contents by 50, the number of pounds in a cubic foot of loose coal.

The car used in the anthracite regions is usually box shaped, the cross section being a rectangle. The content is therefore, very simply found.

Referring to Figure 1, the illustration of the double flare car, the breadth of car at bottom, b, is usually taken 6″ less than the gage of track, while the depth, a, is taken as one-half the diameter of the wheel.

End Gates and Fastenings

To provide a means of egress for the coal from the car while dumping, an end gate is fixed to the forward end. This is swung by from two to four straps on a bar, which latter serves also to support the car sides at the weak end. Before loading the car, the end gate is latched by the loader, a few of the many devices for accomplishing this being shown in Figure 2. The requirements for a good latch are that it shall be so simple that its operation may be easily understood; that it be so constructed as to stand constant rough usage; that it shall not become unfastened through jolting or derailment of cars on haulage ways; and that it be quickly and easily unlatched on the car dump.

Fig. 2. Latches Used on End Gates.

Many of the devices employed have failings in one or more particulars. Latches which are close fitting at the beginning may soon fail through the distortion of the car sides; those consisting of a hook fastened to a chain may fail through the breakage of the chain; those made up of long bars may fail through the bending of the bar and its failure to engage securely both of the side lugs. Because of such difficulties the loader may resort to the driving of wooden wedges to fasten the latch in place, causing exasperating delays on the tipple.

The lift gate has had a rapidly increasing use, and is the standard for use at shaft mines having self-dumping cages. Its superiority over the swing gate lies in its being less liable to come open in the course of travel. It is only when the bolt fastening the straps extending from the end gate to the sides of the car becomes lost that this may happen, and not through excessive jolting on the haulways.

It is true of all end gates, no matter what type of fastening is used, that the open space between the end gate and the car sides permits the leakage of fine coal on the haulway. This in time is ground fine by the passage of cars and the travelling of men and animals and constitutes an additional element of danger in mining, inasmuch as this fine dust is carried about by the air current and would be a powerful aid in the propagation of an explosion.

Cars having drop bottoms are frequently used about mines where the trips are brought out of the mine by a rope, the coal being emptied directly into a bin by releasing the bottom. Closing is effected by the winding up of a chain attached to the bottoms, or it may be so arranged that closing is done automatically as the cars are being moved from the tipple. Drop-bottom cars are fairly common in the coke regions of Pennsylvania. They are advantageous here because with the usual lengthy bin designed to hold a day's charge for the ovens, the long trip of cars can be brought to a stop at any desired point and the bin filled uniformly without the necessity of chain and sprocket driven levellers. They are, however, expensive to keep in good order, leak coal in transit, and any accidental loosening of the bottom causes the wrecking of the trip.

Wagons With Tight Ends

The presence of an end gate makes it impossible to have in the front the same strength and rigidity as found in the rear of the car. Since the sides in front are reinforced at the top only by the bar on which the end gate is hung, the front binder belt must be mainly relied upon to resist the strains encountered in the rough service to which all car equipment is subjected. In time the insufficiency of this support permits the spread of the sides and causes an ill fit with the end gate. Fine coal is dribbled along the roadways. The end gate boards become broken, and in this way, or by accidental opening in transit, enough coal may be spilled to cause a wreck. In order to prevent such an occurrence a constant oversight must be exercised and the end gate and fastenings kept in good repair. During the necessary repair periods such cars are taken off the haulways and the mine is handicapped by the loss of so much rolling stock.

Cars with closed ends are free from these drawbacks. The ends being rigid and connected throughout their depth to the car sides, there is presented the strongest possible construction. All danger of accidental opening of end gate is removed, no fine coal can be spilled on the haulages, the loader is always assured of correct weight on the tipple, the item of gate repairs is completely wiped out, and more cars, therefore, are available for daily service. An additional reason which should carry much weight with the industry is that a car with tight ends can be manufactured at less cost than the end-gate type.

The reason for indifference to the economy in the use of the closed-end type of car in drift mines is doubtless due to the fact that a special type of dump, the rotary, is required for unloading the mine car. This style of dump will be fully treated in the Tipple Section, but it may be stated here that dumps of this type, operated either by motor or by gravity, are on the market and are giving entire satisfaction. It is a safe prediction that the tight-end wagon and the rotary dump will win a gradual ascendancy in American mines.

Drawbars

Drawbars are found on all cars not equipped with spring bumpers, or drawheads. With cars having side bumpers the style shown in Figure 3 is used. For cars having center bumpers some provision must be made to provide room for the insertion of the coupling link. This is effected by an offset at the ends, as shown in the figure.

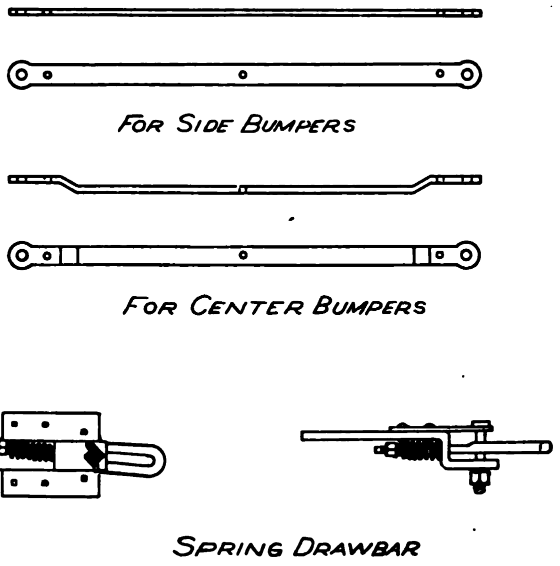

Fig. 3. Styles of Drawbars In Use.

The spring draw bar, also shown, overcomes the disadvantage of the spring drawhead, inasmuch as it adds no additional weight to the car, and is furthermore, inexpensive. It can be used with either side or center bumper cars. Its utility lies in the absorption of shock and a greater smoothness of operation. It can be applied to old mine cars in use by merely welding the new end to the old draw bar, making no further change in the construction of the car.

Drawbars vary in width from 4" to 5" and are usually ⅝", ¾", 1", or 1¼" in thickness. They are connected to the car bottom by ¾" rivets, in the case of a steel bottom, or by ¾" bolts in the case of a wooden bottom.

Bumpers

Mine car bumpers are of two kinds, those consisting of two projections beyond the car, one at each side of the drawbar, and known as side bumpers, and second, where there is but one projection beyond the car, known as the center bumper. Modifications of both types are shown in Figure 4.

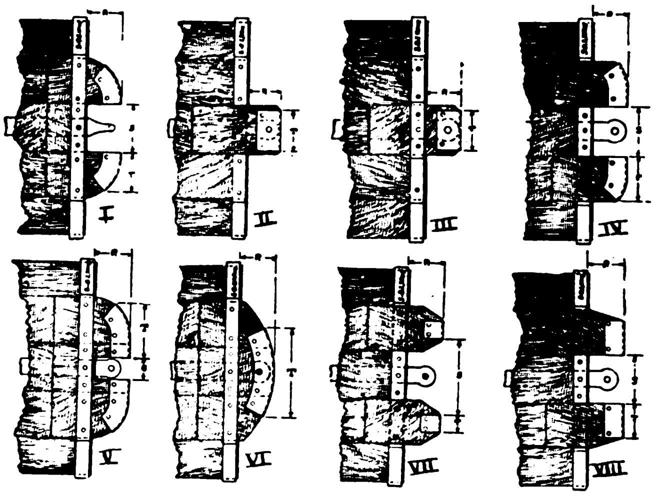

Fig. 4. Modifications of Center and Side Bumpers.

Side bumpers require long chain couplings. In passing around sharp curves there is always danger that the bumpers will inter-lock and cause derailment. Center bumpers here show to a great advantage since they allow cars to go around curves easily and safely provided the connecting link is of the required length. In style VI, a favorite form of bumper, the radius of the face may be mathematically calculated so that the cars will roll on each other evenly when going around a curve, and only a slight play is left in the single link coupling. Center bumpers add much to the life of the equipment as there are absent the corner bumps that strain and rack the car.

Sometimes center and side bumpers are used together, having a double bumper on one end of the car and a single bumper on the other end. This works well on inclines where there is automatic uncoupling at top.

Since with any type, the bumper must stand the shocks due to sudden stopping, or the slackening of speed, they are stoutly built of a double thickness of bottom boards.

Brakes

Many different kinds of brakes are used, all of them depending upon the friction produced by pressing against the wheel a body having a wearing surface shaped to the arc of contact. The brake block may be of wood or steel. In place of the block a band of steel drawn down tightly against the wheel may be made to serve.

The place of application of the brake may be above the center line joining the axles, below it, or midway between these two positions. If above, gravity tends to draw the block, when out of use, toward the wheels and may cause rubbing. This tendency, however, may be counteracted by having a sufficient release of blocks to raise them well above the wheels. If the brake is below the center line the opposite effect is had, but in case of derailment, the brake attachments are very liable to be damaged, causing additional delay and expense in restoring the car to its former good condition. This seldom happens when the brake block is above the wheels, and this is therefore the preferable position. The midway position is frequently assumed when brakes are to be applied on both sides of the car and operated with one lever.

When wood is used a single block generally suffices being made in the shape shown in Figure 5. When set it exerts a pressure against both wheels. Metal blocks are in pairs, one to each wheel. They are cast of a mixture which will resist wear though not as hard in composition as the wheel.

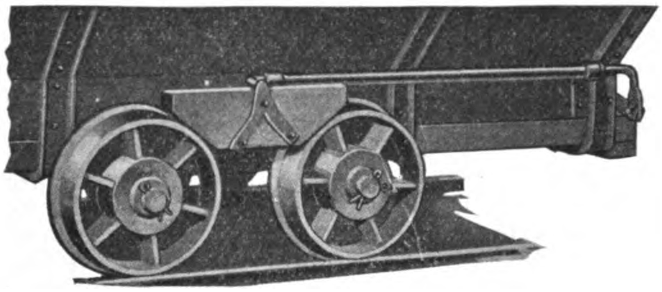

Fig. 5. The Wooden Brake Block.

Sprags are used extensively in the anthracite region in place of brakes. It consists of a pointed cylindrical stick of wood and is thrown between the spokes, locking the wheel and causing frictional resistance by the sliding of the wheel on the rail. This tends to produce flat wheels. The same bad effect is brought about by setting a brake so firmly that the wheels are locked in position and slide instead of revolving and causing frictional resistance by rubbing against the brake block.

Hitchings, Mine Car Couplings

Styles of couplings commonly found in mine use are shown in Fig. 6. The single link can be used only on cars having center bumpers, and where curves of large radii are driven. The other styles are used with side bumper cars though they may also be used with the center bumper type. Patent hitchings, parting in the middle, are on the market. They are easy of manipulation and have the further advantage that each end can be permanently attached to the car, thus being always in place and ready for use. They are so constructed as to prevent coming apart while in service. In all of the other types one end of the coupling may be held in place by a pin with a cotter pin in the end, leaving the other end of the coupling free for connection to the adjacent car. In the double clevis hitching the pins are stoved so that they cannot pass through the upper half of the clevis and become lost. Modifications of the types shown in the figure will be found in the catalog section.

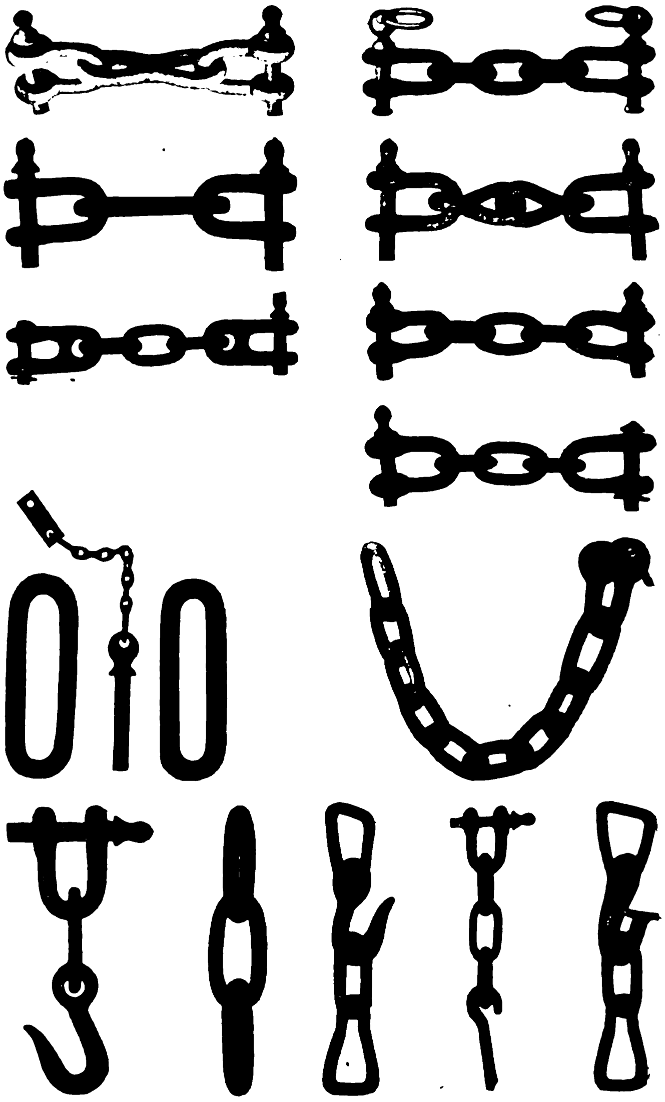

Fig. 6. Hitchings Used On Mine Cars.

Couplings are made of wrought iron while clevises and pins are made in one piece of steel. In each case a high tensile strength in the material is a requirement.

Automatic Couplers; Spring Draw-Heads; Pocket Bumpers

These are placed on cars of the heavier types, and are, in the main, patterned after the equipment used in railroad practice. The advantage of the spring draw-head lies in the reduction of shock. It also assists the motor in starting a train of loads by reason of the movement each receives due to the spring. The disadvantages are the additional weight placed on the car, and the high cost.

Wheels and Axles

Wheels are generally 18″ in diameter though 14″ and 16″ wheels are used with low cars.

From the standpoint of tractive effort a large wheel is much to be preferred to a small one; first, because a small wheel indents the rail more deeply than a large wheel, hence, while in motion must be lifted out of a deeper cavity; second, in passing over grit on the rail or inequalities in the road, the tractive effort, having a higher point of application, gives the larger wheel a greater moment to mount the obstacle; and third, assuming the same load, and therefore the same size of axle, and for example, an 18" wheel in one case and a 36" wheel in the other case, the small wheel will make two revolutions to every single revolution of the large wheel in travelling a given length of track. The hub of the smaller wheel making two rotations about the axle, the frictional loss will be twice that of the larger wheel.

The relation between the diameter of a wheel and tractive effort is expressed by the formulae:

$$F=\frac{k\,P}{r}$$

where F=the horizontal force required at the axis of a circular body to produce and sustain uniform motion,
k=a coefficient determined experimentally
P=the load
r=the radius of the rolling body

The objections, however, to a large wheel are: first, it requires a large axle to take care of side thrust; second, it involves additional weight and cost; and third, large wheels would effect the design of the car, tending to raise the bottom and diminish capacity. The prevailing 18" wheel may be regarded as a compromise size.

Axles are found as small as 2" in diameter, rising from this by 1/8" increments up to 3¼" in diameter. While for the purpose of reducing friction, the diameter should be as small as possible, strength is of far more importance. The size of the axle may be readily computed by considering it as a beam uniformly loaded and supported at both ends, allowing an ultimate strength of 100,000 lbs. per square inch of cross section, and using a factor of safety of 8. Since the size of the axle is clearly proportional to the tare of the car plus the weight of the coal, it follows that the larger size axles are found on heavy cars.

Originally all cars were equipped with square axles clamped tightly to the car bottom. The wear on the axle journal was not distributed over the entire circumference, being greatest at the bottom portion and in consequence after the axle had been in service for some time it wore oval and caused the wheel to wear out internally. New wheels when placed on these worn journals were soon rendered useless.

The round axle, being free to rotate and distributing the wear evenly over the entire surface of the journal, is recommended to meet this difficulty. The earliest round axle consisted of a straight piece of cold-rolled steel with a hole for a cotter pin at each end. This construction allowed excessive sideways play and collars were then shrunk on to the axles, back of the boxes, to get rid of this undesirable feature.

Hollow Axles

The hollow axle shown in Figure 7, makes two claims for distinction, first, being hollow it is the strongest form of construction, weight for weight, that can be presented, and second, the lubricant is stored within the axle from whence it feeds by gravity out of the open end, and thence by capillary attraction and centrifugal force along the bearing surface, escaping at the inner end of the hub and lubricating the surface where wheel thrust is taken. The axle is not rigidly attached but has floating rotary motion as well as floating endwise motion, thus equalizing the wear.

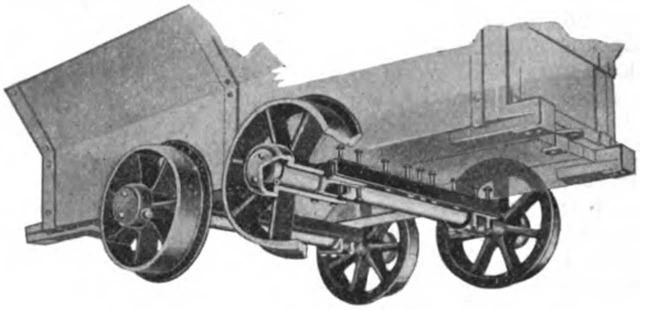

Fig. 7. Hollow Axles.

Methods of Attaching Wheels to Axles

Four methods are possible; first, axles fixed and wheels running loose on them; second, wheels fixed to the axles, the latter running loose in journal boxes which support the weight of the car; third, wheels running loose on the axles and axles running loose in the boxing; and fourth, one wheel fast on the axle and the other wheel loose.

On first thought it would appear advisable to follow the lead of the railroads and adopt the second mentioned, i. e., wheels fixed to the axles. This is, in fact, common practice in the anthracite regions and has been adopted in a number of bituminous mines. A great advantage in their use is the absolute trueness of gage. The requirements are that curves be driven with large radii and that the roads be kept in good order. With fixed wheels one or both of the wheels must slide in travelling around a curve since the outside wheel passes over more ground than the inside one.

The practice of having one wheel loose and the opposite one tight is a compromise measure. In this case both wheels revolve with the axle until a curve is reached when the loose wheel revolves on the axle just enough to relieve the slippage referred to above.

The method prevailing in most mines, other than anthracite, is to have both wheels loose on the axle. In favor of this arrangement are, first, the smaller resistance met with in passing around curves, second, cheapness as compared with the tight wheel and axle, and third, the greater ease of renewal when worn. Where varying grades are encountered and much braking is necessary, there is always the possibility that because of setting the brakes so hard as to slide the wheels, the tread may be worn flat and make it necessary to discard the wheel. With loose wheels this involves less time and expense than with tight wheels.

Fastening Axles to Bottom of Car

Several methods of attachment are used. The earliest method, employed with the square axle, was the axle strap, one at each side of the car and bolted to the car bottom. This form is still used, as also with round axles, the strap, in this case, going around the pedestals and effecting a tying together of the running gear. A second method in use with round axles, is wide-wing four-bolt boxing, inside plates being placed on the car bottom to prevent the enlarging of the bolt holes in the wood.

It is imperative, if satisfactory results are to be derived in the running of the car, that both axles remain absolutely parallel and that they do not shift position in the direction of the length of the car. Because of a constant hard service, and more particularly owing to the manner of dumping, in which the car is thrown forward violently each time, the shock being taken always by the forward pair of wheels and the axle, there is a tendency with the axles to deviate from the parallel and with the bolt holes in the car bottom to enlarge due to wear. To guard against this requires a rigid fastening and a method for the distribution of shock. This is furnished by the use of angles, or channels, running across the bottom of the car and tied together with connecting straps, D. as in Figure 8. The angle, E, gives a much greater support across the bed of the car than with the use of straps or plain boxing. Instead of two angles or channels, a one piece solid steel plate is sometimes used, but it is questionable whether this is in any way superior to the angle or channel truck.

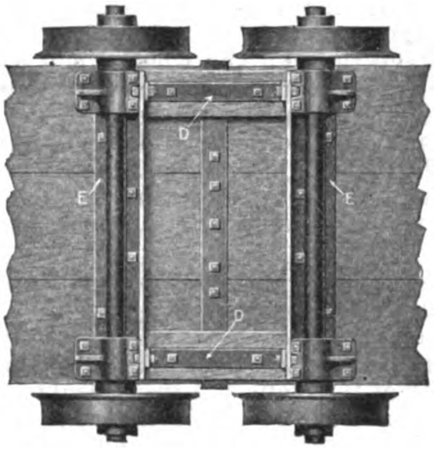

Fig. 8. The Angle-Bar Truck.

Foundry Methods

Car wheels are made of cast iron which as ordinarily cast is a comparatively soft metal. In order to prevent rapid wear on the tread and flange of the wheel it is necessary to make these parts very hard. This is done by chilling the iron during the casting, for which purpose there is used an iron mold. The molten metal coming in contact with this is chilled and there is produced an iron in which all the carbon is in the combined form, i. e., white cast iron. This white iron represents the chill of the wheel and it is on this that the wear of the wheel depends. Once the chill is cut through the tread of the wheel wears ont rapidly. The spokes and hub of the wheel will be of gray cast iron (the carbon here being in the form of graphite) because of the slower cooling in the sand parts of the mold. These parts are therefore less brittle and better able to withstand the shocks of service.

The process of chilling sets up certain strains which should be reduced before putting the wheels into service. To effect this the newly cast red-hot wheels are quickly lowered into preheated annealing pits, after which the pit is sealed and the wheels allowed to cool slowly. After removal from the annealing pit the wheel is now complete and ready for the machine shop. Here the hub is prepared for the journal, or the roller bearing, as the case may be, and for the flange on the boxing. Since these parts are of gray iron machining is easily done.

The making of chilled castings is one of the most difficult problems of cast-iron metallurgy. Every precaution must be taken to keep the metal very close to a given composition as the chill itself will be relatively hard or soft, deep or shallow, depending upon this. Such details as the temperature of the mold, of the chill, and of the metal when cast must be regulated with care. Only the highest grades of pig iron and carefully gathered scrap metal should be used. Because of the certainty of analysis, manufacturers try wherever possible to get back their own wheels after they have been worn out. Other manufacturers condemn the use of any scrap whatever, this prohibition extending even to the re-use of old car wheels of their own make. Sulphur is responsible for this ruling. Every car wheel contains this objectionable element, though it is held to a low point. The old wheel, in being melted in the cupola, comes in contact with coke which imparts to it additional sulphur, producing in the finished product a higher percentage than in the initial cast of the wheel. The contention is that every wheel made from scrap contains more sulphur, and is therefore more brittle, than would be a wheel made entirely from a mixture of pig iron coming from both the coke and charcoal furnaces.

Bearings

More thought has apparently been given to wheel and axle bearings, and the possibilities for reducing frictional resistance, than in any other branch of car design. Certainly any improvement in this direction has a far reaching effect on the expense of coal production. If by the use of a superior bearing, the draw bar pull is halved, it follows that, using the same weight of motor, twice the number of cars can be hauled as heretofore, or else, that the same number of cars can be hauled with a lighter motor. Figured either way it means a savings in operation.

In the case of a plain bearing wheel we have an example of sliding friction, that is, there is continually taking place a sliding of a section of the hub past a section of the axle. By the use of rollers about the axle rolling friction may be substituted for sliding friction, and this, in brief, is the principle on which the roller bearing wheel is based.

There are two different methods of housing the rollers. They may be in the wheel hub, or else in the journal box, which is either on the inside or on the outside of the wheel. The inside journal box is more suitable for the type of car used in the bituminous fields, while the outside journal has a wide use in the anthracite regions, where owing to the heavy loads carried, journal boxes are standard. Also it is found in many metal mines. The advantage claimed for the type with rollers in the box over the other is that with heavy loads the thrust against the flange of the wheel, when rounding curves, cannot pinch the ends of the rollers. Rollers in the wheel are recommended on light, small cars, and in the box for heavy service cars.

The object of roller bearings is, of course, to reduce the frictional loss resulting from the rotation of the wheel about the axle. This reduction is stated to be from 40 to 60 per cent., this is, it requires 40 to 60 per cent. less tractive effort to move cars with roller bearings than with plain bearings.[*]

In order to maintain a lasting superiority over the plain bearing, roller bearings must stand years of hard usage. Any indentation on the axle due to pounding would necessarily affect the performance of the truck. Axles made of a higher carbon steel will resist this, but care must be taken to avoid getting the percentage of carbon so high as to induce breakage.

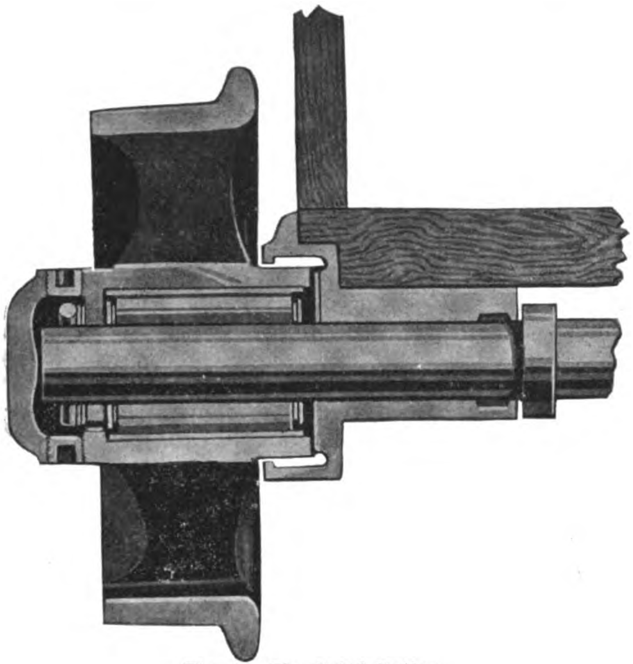

Fig. 9. The Solid Roller.

Two kinds of roller bearings are in use, first, the solid roller as illustrated in Figure 9, and the flexible roller as shown in Figure 10. Each type has its distinguishing features and both have demonstrated their successful application to the problem of reducing frictional losses in mine haulage.

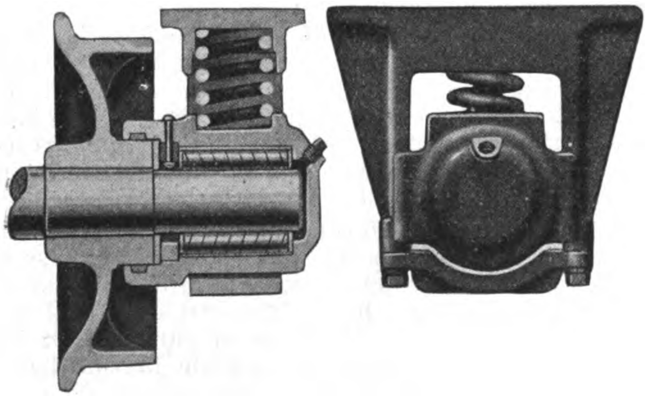

Fig. 10. The Flexible Roller.

Lubrication

Lubrication has for its object the diminishing of friction between moving surfaces. It is a requirement for easiest running that the axle shall not come in contact with the wheel but shall revolve on a thin film of lubricant. Southwick conceives the rotation of a shaft as taking place on molecules of oil, comparing it with the balls of a ball bearing.

A definition if a good lubricant would be—one that possesses minimum cohesion among its particles and at the same time maximum adhesion to the surface to be lubricated. The cardinal principle underlying all lubrication is to use the thinnest, or least viscous, oil that will stay in place and do the work.

The solid hub self-oiling, or cavity type, wheel makes use of either a cheap grade of black oil, or a semi-fluid grease. The black oils are commonly crude oils from which the more volatile portions, as the naphthas and burning oils, have been removed by distillation. The axle is lubricated by the oil coming through the passages in the wheel leading from the reservoir. This is principally the case while the wheel is at a standstill, or travelling at low speeds as when in rapid motion, centrifugal force holds the oil in the reservoir and prevents its having access to the axle. The oil should be of such a consistency that it will feed freely through the passages and yet be sufficiently viscous to retard leakage through the wheel when it is in motion, thus leaving the axle dry and causing increased friction in proportion to the load carried. The interval between oilings depends largely upon the quality of oil used, the construction of the wheel, and the loss of lubricant through a poor fit of the axle or boxing with the open parts of the hub.

In many of the early designs of wheel little attention was given to the wastage of oil. The figures kept by one company showed that the cost of pit car oil alone was three times that of all other lubricants used at the plant.[†] A great deal of this waste may be prevented by employing men as oilers instead of irresponsible boys; by providing an ample and well lighted place for oiling; by using a system of markings showing the date on which each car was oiled; by using a good oiling device, such as a pressure gun, to regulate the amount of oil delivered to the wheel; and by using a wheel designed to prevent leakages.

An objection urged against thin limpid oils is that the centrifugal force developed in the revolving wheel throws the oil away from the axle, thereby preventing its lubrication. Semi-fluid oils, or greases, having more body, are presented as an alternative and are being extensively used in place of the black oils. These are made in the same manner as cup grease, the only difference being that the former is more soft bodied, due to a smaller quantity of saponified fatty oil being combined with the hydro-carbon oil. The consistency does not alter under extreme conditions of heat and cold, and while it finds its way easily into the bearings it does not pass quickly out of the wheel.

Solidified greases are not used with the cavity type of wheel but are in common use with the roller bearing type. The grease shows a high coefficient of friction at first causing a rise of temperature which melts it, producing the effect of an oil-lubricated bearing. It is forced into the bearings with a pressure gun, and being thick is not thrown out by rotation, or squeezed out by the side play of the mine car. Each wheel holds about ¾ lb. of grease and at intervals of from 4 to 18 months, as needed, additional quantities are added to replace that used. Semi-fluid oils are also extensively used with roller bearing wheels.

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[*] For a presentation of data on the reduced tractive effort needed to move roller bearing wheels, see Bulletins No. 114 and 118, June and October, 1916, A. I. M. E.

[†] Mines and Minerals, Vol. 32, pg. 26.

On the matter of lubrication there are champions of each of the three forms of bearings, i. e., the square axle, with cavity-type open-end wheel; the round axle with cavity-type capped wheel; and the round axle with roller bearing wheel.

The advocates of the first mentioned aver that the wear on the bottom of the journal is negligible if the use of "black strap" is discontinued and in its place there is employed a high grade oil or grease having such a viscosity as will make it impossible for the lubricant to be thrown out of the wheel. Instances are freely cited where such wheels run six months and longer with one oiling, though it is admitted that a poorly designed wheel will seriously affect the performance. In the next place there is no boxing to lubricate, as with the round axle, and lastly the wheel is light in weight and cheap as compared with the roller bearing wheel.

In the case of the round axle, it is admitted that there is some difficulty in getting the lubricant to the boxing, but since the axle is not expected to rotate, except sufficient to bring about an even wear on the journal, a lack of lubrication here is not a serious detriment to the easy running of the car. At any rate such a disadvantage is small compared with the benefit of distributing wear on the axle.

The necessity of the roller bearing wheel, it is averred, is based on the change in hauling conditions. While cars were being moved slowly by rope or animal haulage, a very satisfactory lubrication was possible with the plain bearing type of wheel, but with the advent of electric motors and high speed haulage, the oil is prevented by centrifugal force from reaching the axle. Since with roller bearing wheels, the rollers are always in contact with the lubricant, the speed of the wheel is of no consequence.

NOTE—We are indebted to the following manufacturers for illustrations appearing in this article:

American Car & Foundry Co.,
Enterprise Foundry and Machine Works,
Fairmont Mining Machinery Co.,
Hockensmith Wheel and Mine Car Co.,
Hyatt Roller Bearing Co.
Sanford-Day Iron Works,
S. B. Stine,
Watt Mining Car Wheel Co.,

Specifications for Mine Cars

TYPE—

Over-hang Sides

Sloping Sides

Straight Sides

CONSTRUCTION—

All Steel

Steel with wood floor

All wood

CAPACITY—

Required

Gauge of Track . . . .in.

Diameter of Wheel, Exclusive of Flange ....in.

KIND OF WHEEL—

Self-Oiling Capless?

Ring Oiling Capless?

Roller Bearing?

Plain Wheels with Rollers in Boxes?

KIND OF AXLE—

Round?

Square?

Size of Axle . . . .in.

" " Iron Front Binder . . ..in.

" " " Center " . . . .in.

" " " Rear " . . . .in.

" " " Draw Bar . . ..in.

Diam. of Coupling hole in Draw Bar ....in.

Send rough Sketch of draw bar.

Width of Car clear inside at top . ...in.

Depth of Car clear inside . . ..in.

Length of Car clear inside . . ..in.

Length Car overall including Bumpers ....in.

Height Car overall above top of rail ....in.

THICKNESS OF MATERIALS—

Sides . . . .in.

Bottom . . . .in.

Distance to center of Axles, (Wheel Base) . . . .in.

Send rough sketch and dimension of Bumpers.

DO YOU WISH BRAKE—

Single?

Double?

If Single Brake, on which side when facing car from rear?

STYLE OF DOOR—

Lift Door?

Gate hinged at Top?

Gate hinged at Side?

Send rough sketch and dimensions of Couplings.

U. S. STANDARD SYSTEM OF BOLTS AND NUTS

As Recommended by the Franklin Institute, of Philadelphia, December 15, 1864.

Diameter of Bolt	Number of Threads per Inch	Diameter of Hole in Nut	Short Diameter of Nut*	Diameter of Bolt	Number of Threads per Inch	Diameter of Hole in Nut	Short Diameter of Nut
¼ in.	20	.185	½ in.	2 in.	4½	1.712	3⅛ in.
5/16 "	18	.240	19/32 "	2¼ "	4½	1.962	3½ "
⅜ "	16	.294	11/16 "	2½ "	4	2.175	3⅞ "
7/16 "	14	.344	25/32 "	2¾ "	4	2.425	4¼ "
½ "	13	.400	⅞ "	3 "	3½	2.628	4⅝ "
9/16 "	12	.454	31/32 "	3¼ "	3½	2.878	5 "
⅝ "	11	.507	1-1/16 "	3½ "	3¼	3.100	5⅜ "
¾ "	10	.620	1¼ "	3¾ "	3	3.317	5¾ "
⅞ "	9	.731	1-7/16 "	4 "	3	3.566	6⅛ "
1 "	8	.837	1⅝ "	4¼ "	2⅞	3.825	6½ "
1⅛ "	7	.940	1-13/16"	4½ "	2¾	4.027	6⅞ "
1¼ "	7	1.065	2 "	4¾ "	2⅝	4.255	7¼ "
1⅜ "	6	1.060	2-3/16 "	5 "	2½	4.480	7⅝ "
1½ "	6	1.284	2⅜ "	5¼ "	2½	4.730	8 "
1⅝ "	5½	1.389	2-9/16 "	5½ "	2⅜	5.053	8⅜ "
1¾ "	5	1.490	2¾ "	5¾ "	2⅜	5.203	8¾ "
1⅞ "	5	1.615	2-15/16"	6 "	2¼	5.423	9⅛ "

* Or Size of Wrench.

Duncan Foundry & Machine Works

Factory and Office

ALTON, ILLINOIS, U. S. A.

Manufacturers of

Roller Oiled Car Wheels

Products

Duncan's Patent Car Wheels, Mining Cars, Car Irons; Shaker and Revolving Screens; Fans; Cages, Tipples.

Duncan's Roller-Oiled Wheel

Duncan's Patent Roller-Oiled Wheel was designed to supply the demand for a solid-bearing car wheel, without caps or bolts, having no parts to come loose, and allowing the ends of the axles to be exposed for the inspection of the lynch pins and collars and which, finally, was perfectly lubricated.

Lubrication

The perfect lubrication (which means simply the right quantity of the lubricant in the right place all the time without waste) is obtained as follows:

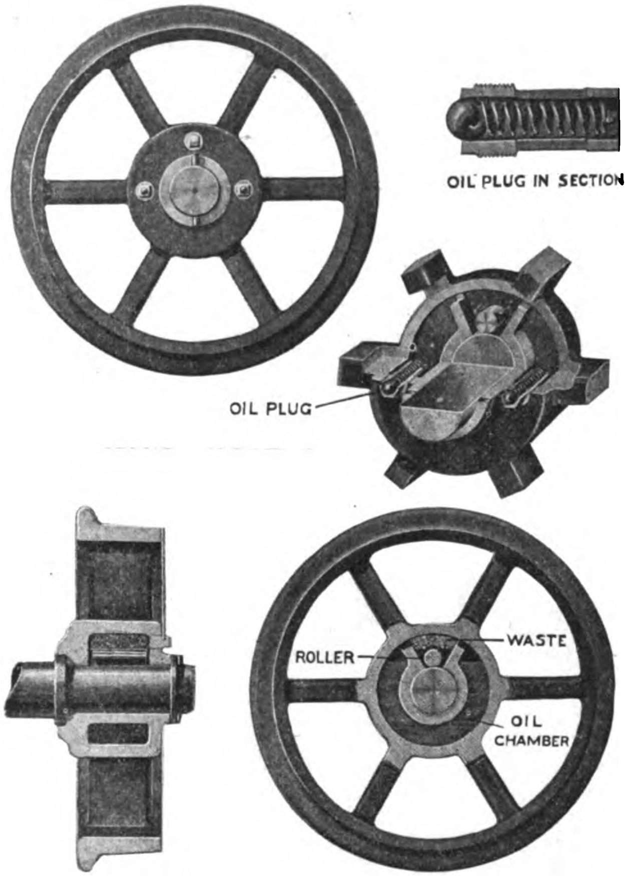
In the oil chamber of the wheel will be found two openings marked oil plugs. These are made up of self-contained plugs in which are placed hardened steel balls 5/8-in. in diameter, held against a ground seat by a spring, which not only makes the wheel oil tight but also makes the closing of the oil-chamber automatic. The two oiling plugs insures a position of the wheel where the oiler is compelled to fill the chamber at least one-half full.

The annular opening is divided into two compartments by two partitions. The partitions each have an opening leading from the oil-chamber into the other compartment in which is packed a wool waste which prevents a running flow of oil but permits sufficient flow to insure perfect saturation of the wool.

Between the journal and the oil-saturated waste is placed a roller about four inches long. There is a space of one-half inch between the awste and the roller which gives the roller an opportunity to rise and fall when the wheel is in motion. When the roller falls on the waste the roller is covered with oil, and as the wheel rotates it in turn falls on the journal and transmits the oil to it. The roller does not feed a large quantity of oil at each revolution, but the frequency of the lubrication imparts sufficient of the oil to keep the journal well lubricated without waste.

In the small chamber are two steel bars, which prevent the waste from dropping down on the journal and losing its position. The waste is placed in such a position that the oil coming from the oil-chamber must pass through it before reaching the roller, thus straining the oil of impurities. Also, the waste does not come in contact with the moving ournal as is the common case, hence receives no wear except the very light roller, and even this is lessened by the lins.

Should it become necessary after an extended time, to remove and replace the waste: In the face of the chamber is screwed a plug, which upon removal, exposes the waste, permitting easy removal and replacing.



Wear

It is our practice in this new design to equally distribute the load evenly over the wheel journal. To do this the center of the wheel is placed directly in a line perpendicularly above the point where the wheel engages the rail. With this construction the life of the wheel is extended at least fifty per cent., and the friction in running is reduced in proportion.

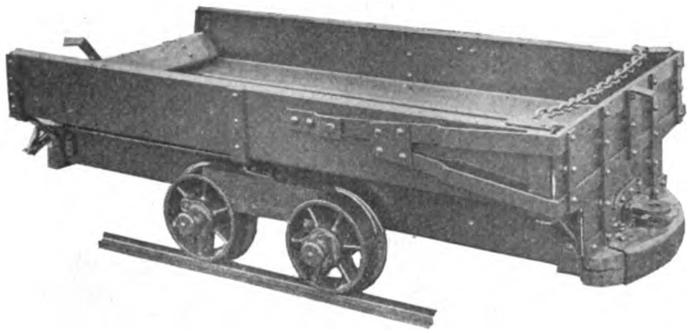
AMERICAN CAR & FOUNDRY CO.

Address for Mine Equipment

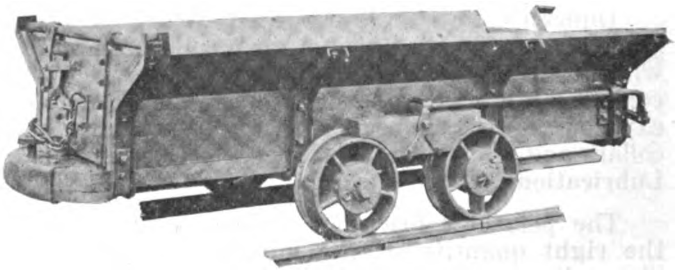
BERWICK, PA.

We have built cars of every kind, made wheels, castings, flange-pipe and fittings, and rolled bar iron since 1860, and at the present time have the largest car plant in the world.

Our experience and facilities are at your service.

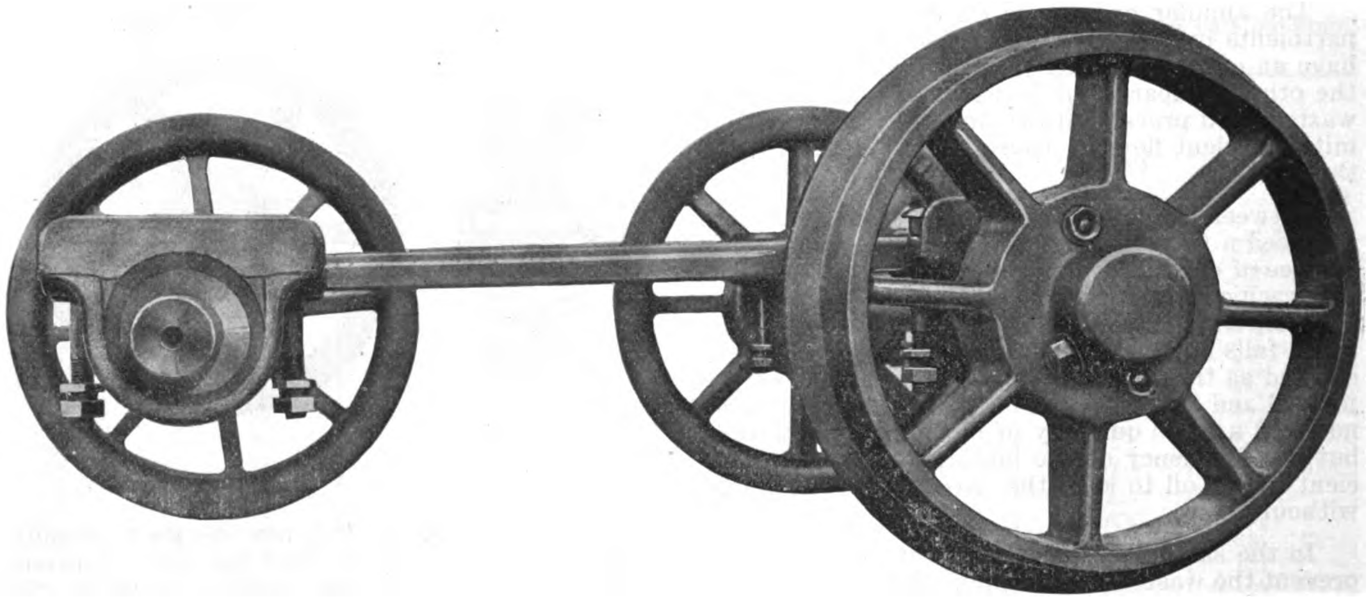


Composite Car—Lift End Gate.



Wood Car—Swinging End Gate.

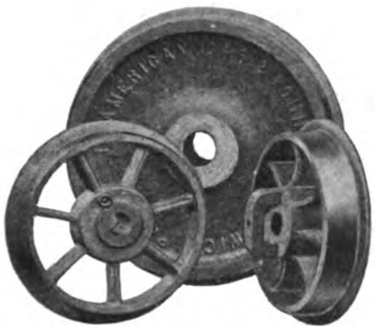
Two of our latest designs of Mine Cars for bituminous coal. Lift end gate as shown permits coal to run out better; has no latches to bother with and other advantages over the swinging end gate as shown. We build Mine Cars, Clay Cars, Dump Cars, Industrial Cars & Railway Cars of wood or steel as desired. Designed to meet your requirements; capacity, 75 Mine Cars per day.



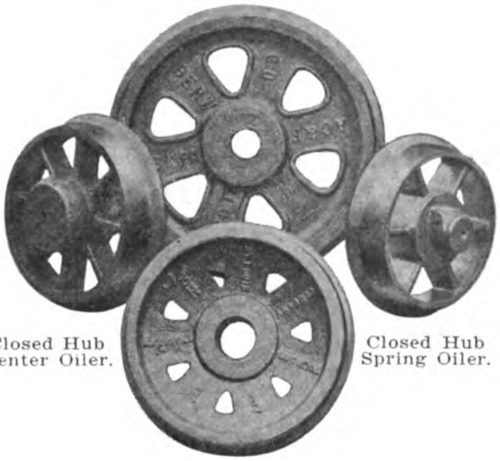
Mine Car Trucks

Our patented Mine Car Truck—equipped with any style wheel desired,—either plain, self oiling or roller bearing. Will run a long time lubricated with grease or oil.

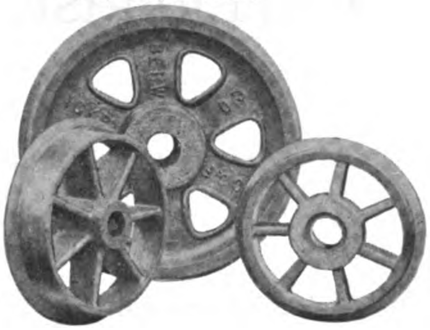
Plate Type Motor.



Spoke Type Motor



Spoke Type Motor.

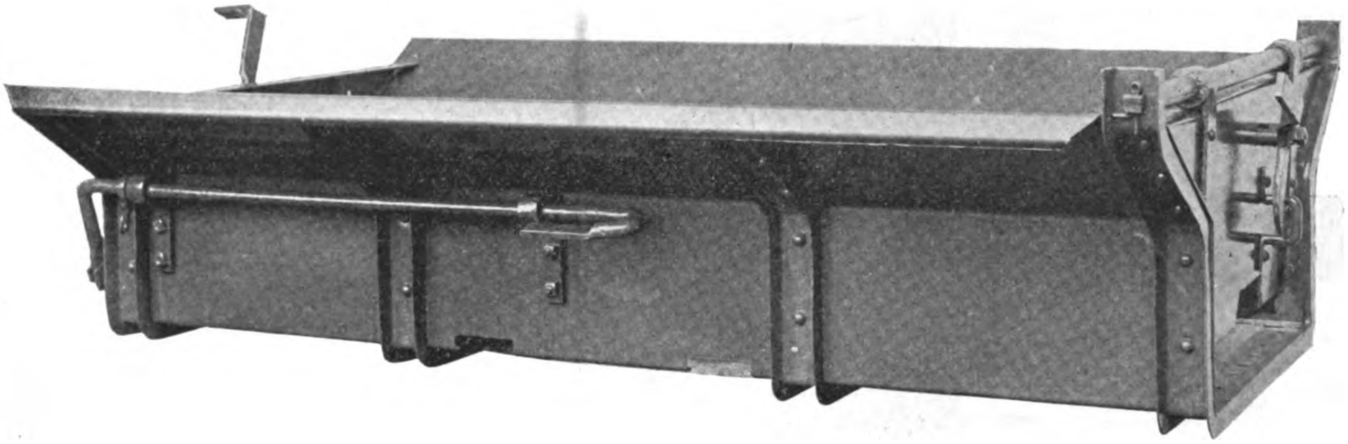


Chilled Iron Wheels

We make 500 mine car wheels and 600 freight car and motor wheels per day. If you have trouble with wheels, cutting down in tread, broken flanges, etc., let us put wheels in for you under guarantee. We can furnish any style to fit your axles.

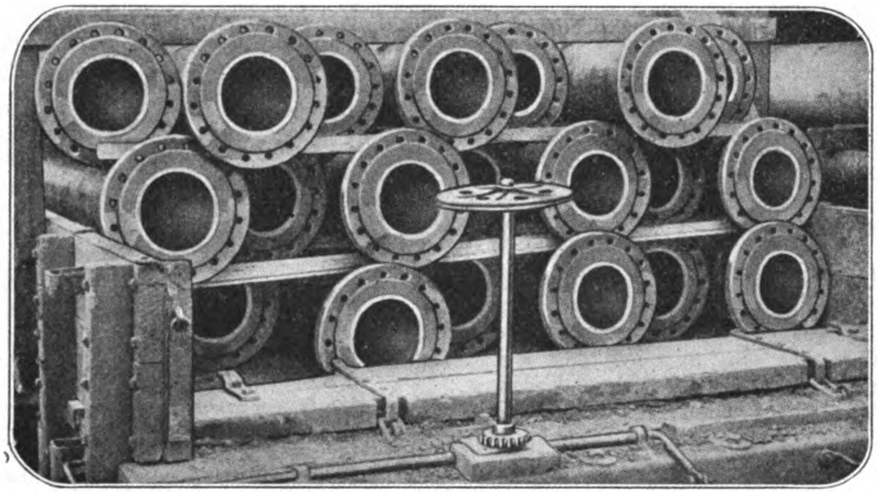
Motor and Street Car Wheels

Of chilled cast iron—all patterns in stock. We furnish new wheels and axles or refit old axles.



Iron Work; Press Work; Forgings; Bar Iron

We roll bar iron and are prepared to furnish iron and press work and forgings of every description. Estimates furnished on application.



Wood Lined Flange Pipe and Fittings

We make a specialty of wood lined flange pipe and fittings for use in mines with acid water. Our flange pipe is cast on end in dry sand moulds, thereby, avoiding the use of chaplets, insuring concentric metal and producing a superior casting. We make all kinds of gray iron castings.

ENTERPRISE FOUNDRY & MACHINE WORKS

Mine Wheel Department

OFFICE AND WORKS: BRISTOL, TENNESSEE

Manufacturing Enterprise Chilled, Annealed, Roller Bearing Car Wheels for Mines and Industrial Railways. Car Trucks of All Types to suit every condition and service.

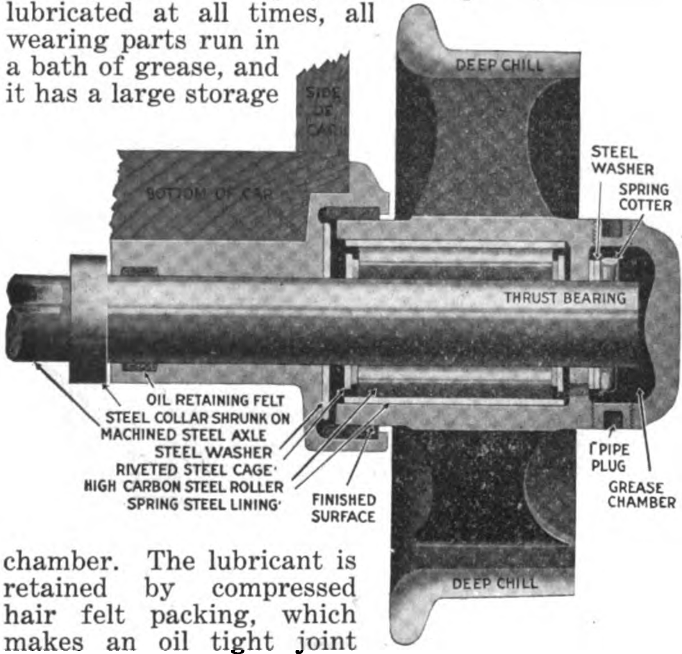
Mechanical Features of the Enterprise Roller Bearing Wheel

Special high carbon solid steel rollers ground true to .001 of an inch.

Hub lined with a spring steel lining, pinned in so it can't come out.

Rollers the full length of the bearing held in place and parallel by a steel cage.

The bearing is perfectly housed and protected; it has proper lateral play and can't pinch; it is well lubricated at all times, all wearing parts run in a bath of grease, and it has a large storage chamber. The lubricant is retained by compressed hair felt packing, which makes an oil tight joint around both the wheel hub and the axle. This not only keeps the grease in, but keeps grit, dust and water out.



The gage or load line falls directly over the center of the rollers, making a balanced bearing, with no tendency to pinch at the ends.

The wheel is a solid one-piece casting—no cap to work off or lose, no bolts to work loose, no gasket to leak oil.

The wheel is retained on the axle by the simple, effective, old-fashioned lynch-pin and washer. These work inside the grease chamber, are perfectly lubricated at all times and detract in no way from the effectiveness of the frictionless bearing.

The metal is chilled semi-steel and is unexcelled in wheels of any manufacture.

Strength

The Enterprise wheel is designed with sufficient safety factor to stand up under extreme overloads and unusually severe service. The Enterprise Foundry and Machine Works back their product with an absolute guarantee of FIVE YEARS' satisfactory service in all wearing parts, tread, flange, spokes, and bearing.

Design

In design it is practically fool-proof, yet easily accessible, and can be removed, repaired and replaced by the simplest workman. The wheel is a solid one-piece casting, with no bolt nuts or gaskets to work loose, and no exposed parts to break off or lose. It is held by the efficient lynch-pin and washer. This, combined with the closed hub, self-oiling features makes a wheel which has neither the drawback of tricky methods of holding the wheel on the axle, nor the useless oil waste of the exposed lynch-pin.

Efficiency

Numerous experiments have demonstrated beyond all doubt the efficiency of the roller bearing itself both in saving of oil and power. The following table gives the results of a test made by the engineers of the Stonega Coal and Coke Company, on April 24, 1915, at Mine No. 4 of the Roda, Va. Plant.

Test to Determine KWH Required to Haul 1 Ton Coal in Cars Equipped With Various Types of Wheels.

Run	Average Min. Elapsed Time	Total KWH Consumed	Motor and Empty Cars KWH	Loaded Cars Consumed KWH	KWH Per Ton of Coal
BUSHED PLAIN BEARING WHEELS.					
No. 1	8. sec.	7.2	1.8	5.4	.18
No. 2	7.25 sec.	7.6	1.8	5.8	.193
Average	7.42 sec.	7.4	1.8	5.6	.1865
WELL KNOWN ROLLER BEARING WHEEL.					
No. 1	6.40 sec.	5.4	1.8	3.6	.12
No. 2	6.25 sec.	4.6	1.8	2.8	.093
No. 3	6.25 sec.	3.8	1.8	2.	.066
Average	6.30 sec.	4.6	1.8	2.8	.093
ENTERPRISE ROLLER BEARING WHEEL.					
No. 1	6.45 sec.	4.4	1.8	2.6	.086
No. 2	6.05 sec.	4.4	1.8	2.6	.086
No. 3	5.30 sec.	3.6	1.8	1.8	.060
Average	6.06 sec.	4.13	1.8	2.33	.077

This test brought out conclusively that Enterprise Wheels require 60% less power to haul than the best plain bearing (brass bushed) wheels and 10% less than another high grade roller bearing wheel.

FIVE-YEAR ABSOLUTE GUARANTEE CONTRACT

Enterprise Solid Roller-Bearing & Self-Oiling Mine Car Wheels

SPECIMEN COPY

ENTERPRISE FOUNDRY & MACHINE WORKS

This is a **signed** 5-year contract with the buyer, absolutely and unqualifiedly guaranteeing perfect **wheel service.**

Guarantee

The Guarantee reproduced here is an absolute guarantee-contract, insuring FIVE YEARS' satisfactory service in tread, flange, spokes and bearing. It is the most liberal and far reaching of any guarantee ever signed by a wheel manufacturer. It makes absolutely impossible anything but a satisfactory and profitable investment. It is an iron-clad assurance of the fact that Enterprise wheels make good, and cannot do otherwise.

THE FULTON-KENOVA MINE CAR CO

General Office
CLEVELAND, OHIO
Works
CANAL FULTON, O. KENOVA, W. VA.

MINE CAR SPECIALISTS

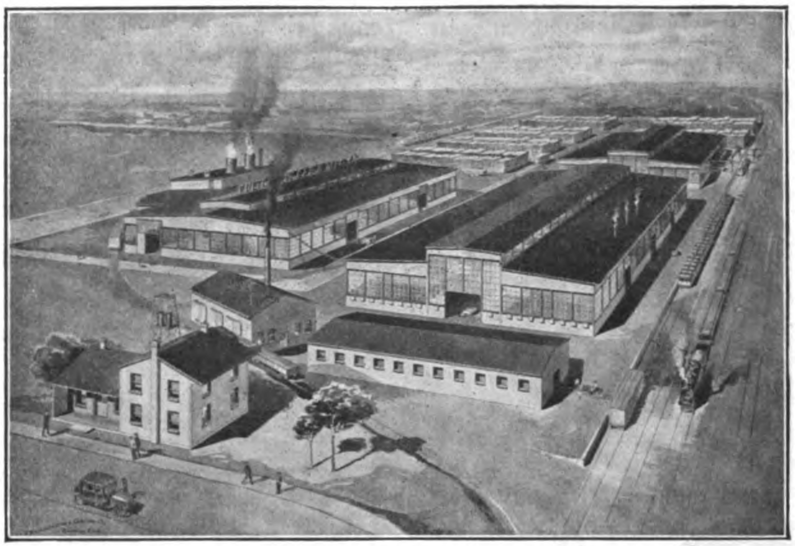
Manufacturing
Wood, Steel or Composite Mine and Clay Cars, Mine Car Irons, Trucks and Wheels to any Specifications

Products

Mine Cars, Wood, Steel and Composite. All styles of Wheels, plain-bearing, self-oiling and roller-bearing. Car Irons, Motor Wheels.

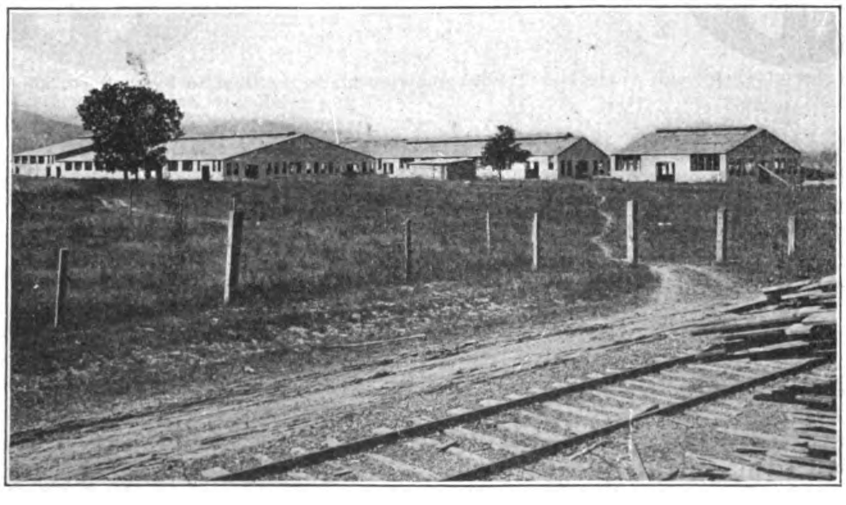
We are prepared to bid upon your specifications, or submit original drawings for your approval.

SUBSTANTIAL PROFITS ARE REALIZED BY MINE OWNERS USING



MODERN CAR EQUIPMENT MADE IN OUR EFFICIENT FACTORY

The above cut shows our shops, located at Canal Fulton, Ohio, on the B. & O. and Penna, Railroads, 56 miles southwest of Cleveland, Ohio. The Capacity and Output of the Plant has been materially increased within the past year. The machinery and equipment throughout is the most modern and efficient obtainable. The employees are men of unusual ability who aim at the highest notch of efficiency.



The above cut shows our plant at Kenova.

Location and Facilities

This plant is located at the confluence of the Ohio and Big Sandy Rivers, at a point where Ohio, West Virginia and Kentucky converge. This, combined with our railroad facilities, gives us an economic advantage which means a saving for you, as well as for us.

We have direct switching facilities into our plant from the following railroads: Chesapeake & Ohio R. R., Baltimore & Ohio R. R., Norfolk & Western R. R., Carolina, Clinchfield & Ohio R. R., Virginian R. R. and Ohio River for barge shipments.

Our plant covering 12 acres of ground and buildings aggregating floor space of 3⅝ acres, for the manufacture of mine cars—the most modern plant of its kind in America. All machines individual motor-driven. Equipped to produce 60 complete mine cars daily. Capacity of No. 1 cupola, 300 car wheels per day.

Progressive Operators and Miners Recognize the High Standard of Fulton-Kenova Cars and Wheels.

Materials

Those entering into our products are the best obtainable and give maximum results. They are rigidly inspected, thus insuring constant quality, and are treated and finished in our own factory after the most approved and up-to-date methods. White Oak Lumber used in our cars is carefully selected and inspected. The Chemical and Physical Tests of our Wheel Mixtures are carefully supervised. No scrap-iron is used and we guarantee a superior wheel of great strength and deep chill.

Workmanship

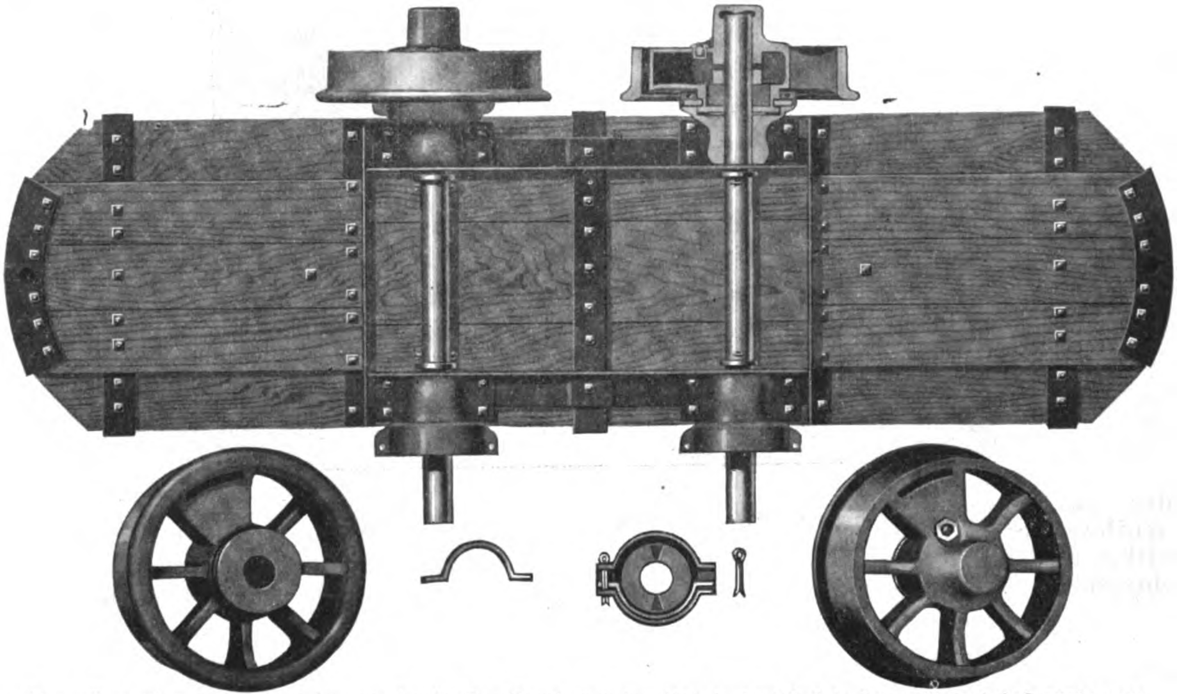
is of the highest quality. Our employees are trained and efficient specialists and absolute, expert workmanship, features each particular part of our construction work.

Cars

We construct cars to suit any required specifications or local conditions. Our Engineers are at your serivce gratis. We check and call attention to all weak points in any specifications coming to our office. Approved specifications are strictly adhered to. Each completed car is examined for flaws or variations before shipment. We guarantee our Cars to stand the most exacting tests.

Car-Irons

Fulton Car-Irons may be duplicated at any time. All repair parts can be replaced, and they will fit. This is important to the Mine Superintendent. Our Irons are well made, correctly shaped, and their enduring qualities cannot be surpassed.



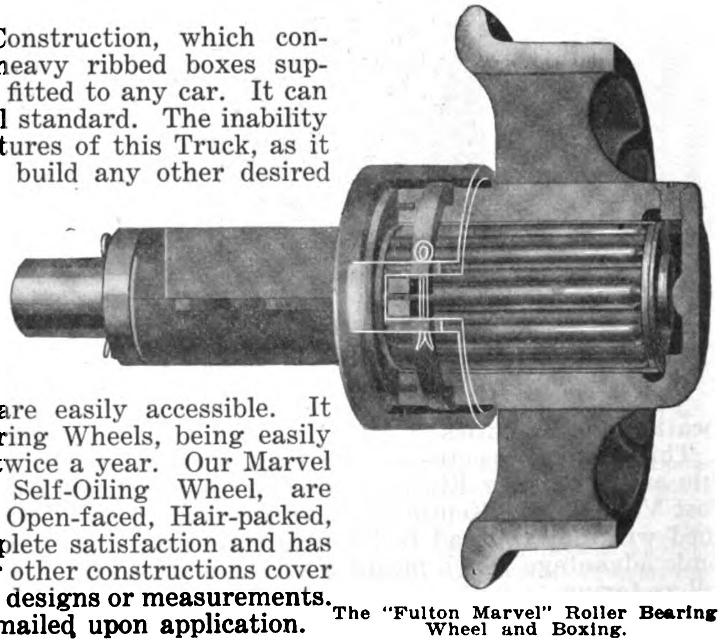
The effectual service given by our Angle Bar Truck construction is testified to by well satisfied customers.

Trucks

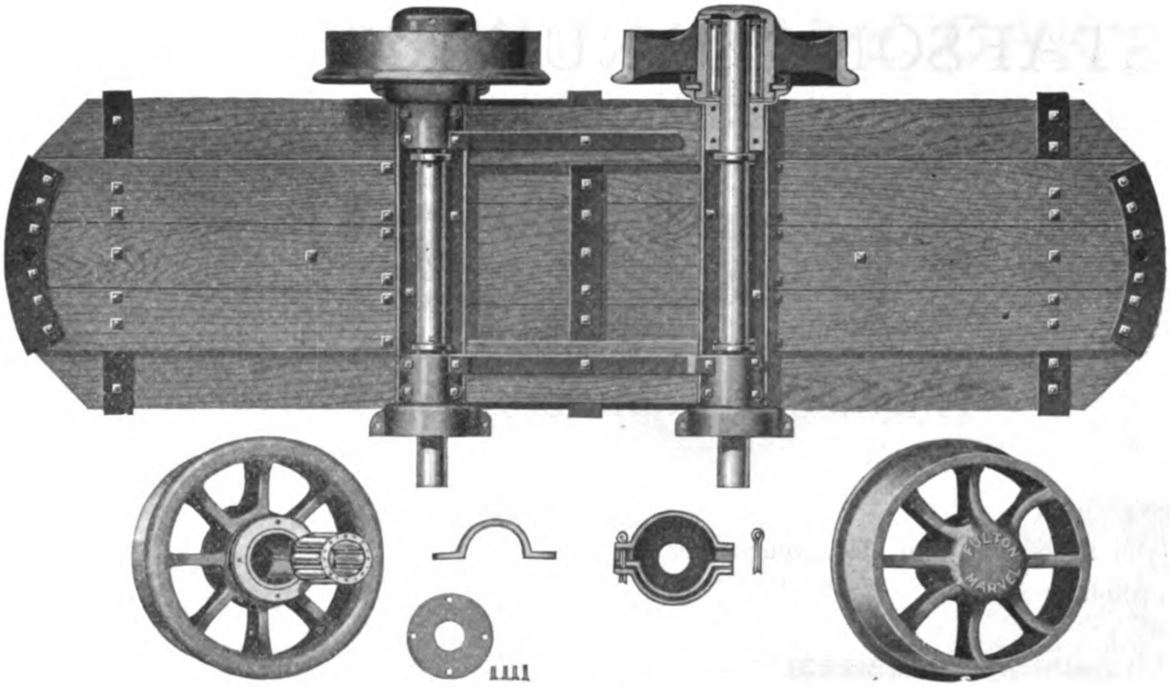
We call attention to our Angle Bar Truck Construction, which consists of two side angles, two cross angles and heavy ribbed boxes supporting the axle. This particular Truck can be fitted to any car. It can be made, also, to conform to your present wheel standard. The inability to get out of alignment is one of the strong features of this Truck, as it makes the car durable, and easy running. We build any other desired style of Trucks.

Wheels

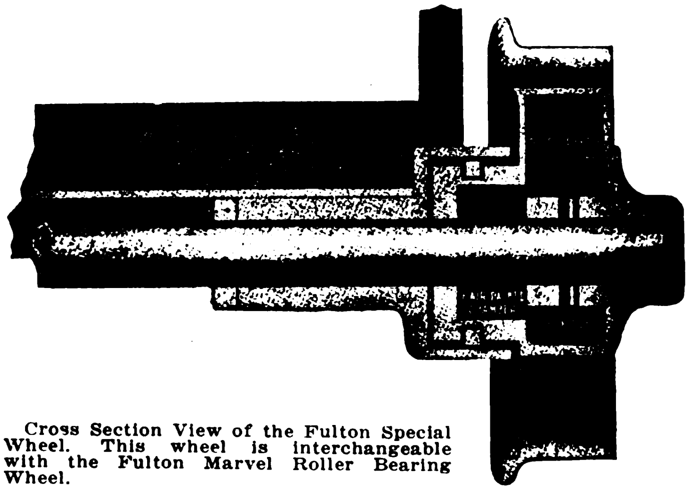
Our Improved Roller Bearing Wheel, is the most valuable proposition we offer. It is recognized as the best qualified wheel of its kind on the market, and is the result of long years of experiment and study along the line of anti-friction bearings. The design is simple, and all parts are easily accessible. It excells in every detail, other so-called Roller Bearing Wheels, being easily removed and requiring lubrication but once or twice a year. Our Marvel Roller Bearing Wheel and Special Hair-Packed Self-Oiling Wheel, are interchangeable. We manufacture the Fulton Open-faced, Hair-packed, Cage Valve Oiling Wheel, which has given complete satisfaction and has proven itself to be one of our best sellers. Our other constructions cover any style of wheel to conform with any particular designs or measurements. Full description of our different wheels will be mailed upon application.



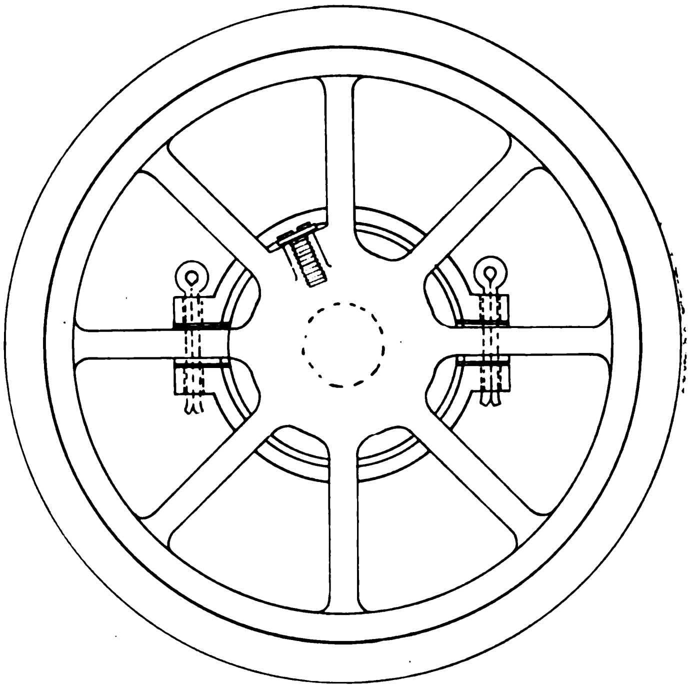
The "Fulton Marvel" Roller Bearing Wheel and Boxing.



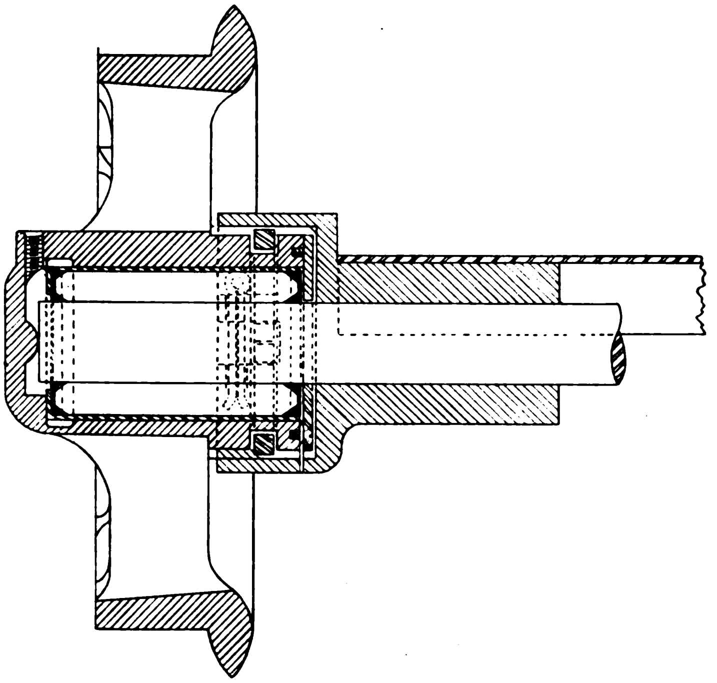
Channel Bar Truck Construction.



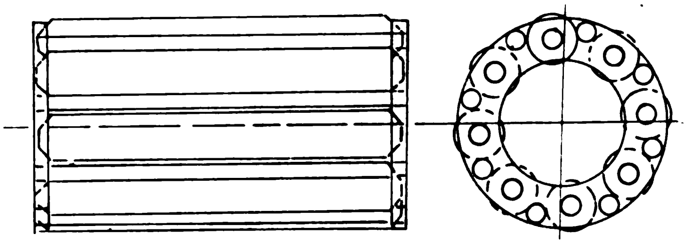
Cross Section View of the Fulton Special Wheel. This wheel is interchangeable with the Fulton Marvel Roller Bearing Wheel.



Outline Drawing of Our Wheel.



Sectional Drawing of Wheel.



Showing Roller Bearing Construction.

Catalog

Descriptive literature and Catalog explaining all our new features and products will be sent to you upon request.

Organization, efficiency and modern equipment, is the key to our low prices and unquestioned quality.

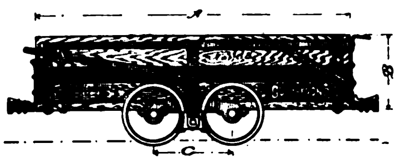
GUSTAFSON MANUFACTURING CO.

CHATTANOOGA, TENN.

TRADE
MFD BY
GUSTAFSON
MFG CO
MARK

Engineers, Founders, Machinists

Good News
is what you hear when you place your order for Gustafson Rolling Stock, etc.



We make a specialty of "Gustafson LEADER,, Chilled Tread ROLLER BEARING MINE CAR WHEELS, "Gustafson LEADER" Chilled Tread Self-Oiling Mine Car Wheels, PRESSED STEEL MINE CAR TRUCK FRAMES, Mine Cars, either wood or steel; Contractors' Cars, Circular Dump Cars, Incline Cars, Incline Rollers and special high-grade car castings, either in semi-steel or other special mixtures for making strong castings; Motor Wheels, Sheave Wheels, etc.; also axles for all kinds of narrow-gauge industrial cars, etc.

Gustafson "Rapid Fire" Car Wheel Oiler

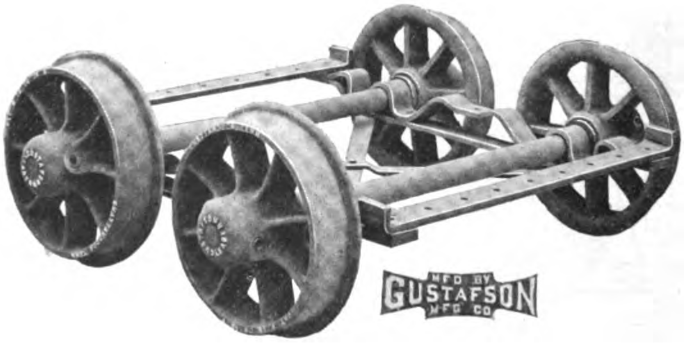
is the easiest and quickest device for oiling all kinds of open hub mine car wheels, and each oiler will save barrels of oil each month.

It is clean in operation and very convenient. It is simply a single-acting Spring Pump attached to a gallon can substantially made and guaranteed.

The Gustafson Leader Roller Bearing Wheel

is properly balanced—is fastened to axle by two loose steel pins inside of wheel and engaging each side of groove near the end of axle. This device is stronger than any other type of wheel lock, and the wheel can be easily taken off and replaced on axle without the necessity of having car turned over.

These wheels, in combination with our Pressed Steel MINE CAR TRUCK FRAMES, which are adapted to any type of wood bottom mine car, make a combination that has proven money makers wherever used.



IRWIN FOUNDRY & MINE CAR CO.

Factory and Office, IRWIN, PA.

Manufacturers of Mine Cars and Wheels

Products

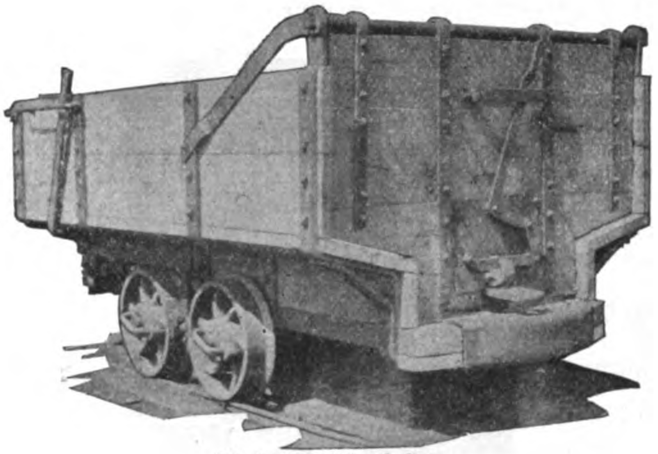
MINE CARS—Any Type.

WHEELS—For Mine Cars and Industrial Trucks, Roller-Bearing or Plain Self-Oiling.

CASTINGS—High-Grade Grey Iron Castings of all kinds.

Mine Cars

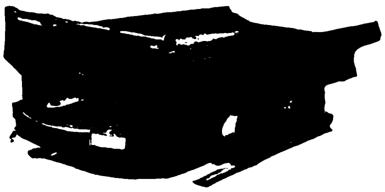
We build all types of mine cars. The two illustrations show mine cars differing in size and construction. The large three ton car is our standard wooden construction, and the small one ton five cwt. car has a wooden bottom and steel sides made in sections, to make it easy to rebuild damaged cars in the mine repair shop.



High Vein Wood Car.

Both cars are equipped with steel center bumpers, channelbar trucks, dustproof bearings, cold rolled steel axles. The large car runs on "Yoke-Oiler" wheels; the small car on "Sensenich" wheels.

All these special features have been designed to meet the demand for a mine car that will stand hard usage with small maintenance cost.



Low Vein Steel Side Car.

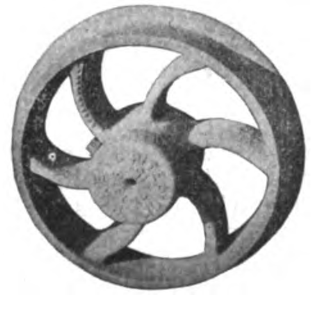
Our Engineering Department will gladly consult with you and design a car to suit your conditions. If you build your own cars, we can furnish the irons already punched and bent.

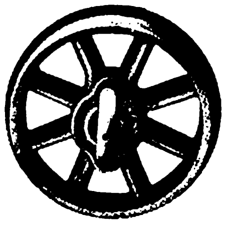
Wheels

We have made many kinds of wheels, but our experience has shown us that the wheels illustrated will suit the conditions at any mine. All our Wheels are made of the best grade of pig iron, are well chilled, and carefully machined.

"The Solid Hub"

The advantages of this wheel are obvious. The oil hole is on center, and, therefore, is easily accessible. The wheel can be half full of oil at all times, making frequent oiling unnecessary.



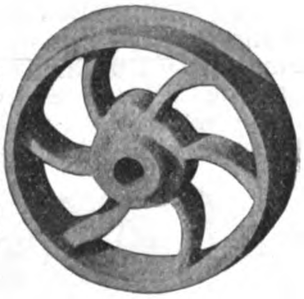


"The 'Yoke' Wheel"

Our "Yoke" Wheel was developed from the Solid Hub Wheel, and has all its good features. The oil hole is centrally located; the wheel is, therefore, easily oiled; the oil chamber is large, the wheel will, therefore, run a long time on one oiling; the linch pin is accessible and the wheel is, therefore, easy to put on and take off.

"The Spring-Oiler"

This is the wheel that you should use when there are some special conditions that require that no part of the wheel or car shall protrude beyond the end of the axle. This wheel has a large oil chamber and can run through grit or water without injury to the wheel.

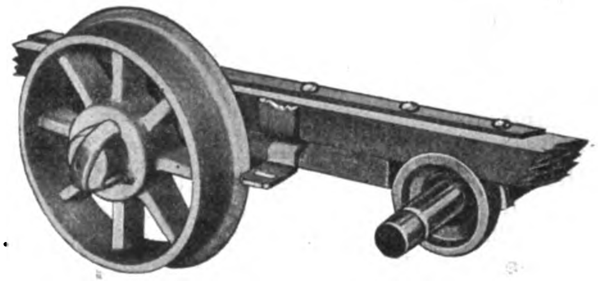


The Sensenich Truck

The very newest departure in mine car equipment. The features of the wheel that will especially appeal to the operating man are as follows:

It is always in gauge, therefore runs easily without washering out or in.

It is a center oiler, therefore easily oiled.



It has a closed hub, therefore none of the oil is wasted; all of it lubricates either the wheel or the bearing.

It can be applied or removed easily.

The truck is equipped with Cold Rolled Steel Axles, and dustproof boxes, with channels for heavy, big vein cars; without channels for light, low vein cars.

We would be pleased to furnish you a truck for six months' trial.

Roller Bearing Wheels

We make roller bearing wheels equipped with Hyatt flexible bearings. Our wheel is of the enclosed hub type, and it therefore an oil saver. The design has been approved by the Hyatt Roller Bearing Co.

Other Wheels

If you have a Wheel of any special design, or have any preference for some standard design, other than those described above, we would be pleased to quote you prices.

Grey Iron Castings

We make a specialty of all kinds of close-grained Iron Castings, especially for mine use; such as—Frogs, Piston Heads and Rings, Bushings, Liners, Bearings, Grate Bars, Boiler Door Liners, Coke Oven Frames, Pipe Specials, Etc.

LET US BID ON YOUR CASTING AND PATTERN WORK.

THE HOCKENSMITH WHEEL & MINE CAR CO.

(Established 1875)

PENN STATION, PA.
PITTSBURGH DISTRICT

Huntington Supply & Equipment Co.
Huntington, West Va.

Webster & Co.
Knoxville, Tenn.

Products

Mine Car Wheels, any style; Self-Oiling or Roller Bearing; Angle Bar Truck, (the Truck that is designed for hard service); Mine Cars; Steel, Wood or Composite; Sheaves, Rope or Bell; Cast Iron Pipe; Frogs; Turnouts; Mine Car Hitchings; Motor Wheels, Steel Tires re-turned.

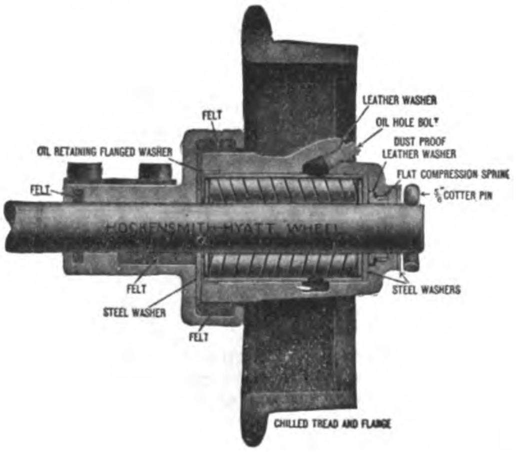
Wheels

The "DEPENDABLE MINE CAR WHEEL" is designed and made to meet the severe conditions imposed by long hauls, increasing loads and motor haulage. This type of wheel can only be obtained:

First—By the use of high grade iron in order to secure strength and proper depth of chill. Since the chill is affected by the chemical properties of the iron, it is imperative that the composition of the iron be accurately known. Our iron mixtures are carefully made daily, so that the casting will not be weak due to the use of iron of incorrect analysis. Another operation is just as essential and that is

Annealing

We have special arrangements in our factory for the proper annealing of our Mine Car Wheels. All our mine car wheels are subjected to this process, which results in a wheel having strong hubs and spokes without in any way softening or affecting the chill.



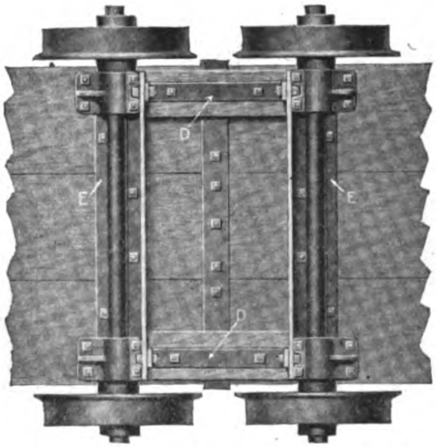
Aside from considerations of strength and wearing qualities there are others such as economy in the consumption of lubricant. To those interested in this phase of the question, we call attention to our

"Eureka" Wheel

The merits of this wheel may be briefly described as

First—Exposed Linch Pin type. This type of wheel permits easy removal and replacement. Accidents due to lost or defective linch pins are minimized, owing to the facility with which these defects can be discovered.

Second—Large oil reservoir in the hub. This hub has a sufficient capacity to insure lubrication of the wheel without re-oiling in from two to four weeks depending on the service.



Third—Simplicity of valve construction. This valve is held in position in a pocket cast on the outside of the shell of the oil chamber, so that it cannot get out of order and thus affect its operation.

Fourth—Dust, dirt and water are effectually excluded from the oil chamber due to the accurate seating of the valve in the oil hole. This dirt and sand feature is very important, especially where motor haulage is used, as it is well known this sand frequently accumulates on the internal spring oiling valves known as "Push Button" type and is washed into the oil chamber with the lubricant when the wheel is being oiled. When this hard sand once enters the oil chamber it works its way down on the axle and materially assists in cutting out the hub.

We have now scattered throughout the mining districts of the United States, over one-half million of these wheels in daily use, and as we are casting them at the rate of six hundred per day, they must possess the merits which we claim for them. The first design to stand the test of time and reach the million mark in production.

We wish to call your attention to the fact, however, that we manufacture other than the **"Eureka"** type of wheel. We can furnish wheels similar to any design now on the market and to fit your present axles. Our Push Button wheel is an improvement over the other types of wheels of this kind now on the market in that we have provided a machine seat for the valve, as well as a long spring, which arrangement insures the accurate seating of the valve. We can also furnish wheels having bolted on caps or with cast on solid ends. Also a semi-enclosed end type having an oil hole at the center—can be oiled while in motion. Also

The Hockensmith-Hyatt Roller Bearing Wheels

In designing this wheel we have endeavored to keep in mind the many advantages of an exposed linch pin type of wheel. Capped wheels are furnished when desired. The oil storage features usually obtained by having the end solid are secured by a leather washer held close to the axle by means of a flat compression spring. As this wheel incorporates the Hyatt Flexible Nickel Chrome Steel Roller, we are not under the necessity of increasing our hub diameter for oil storage purposes, since this is taken care of by the rollers being hollow. This type of wheel requires lubrication but from two to four times per year, depending upon the service.

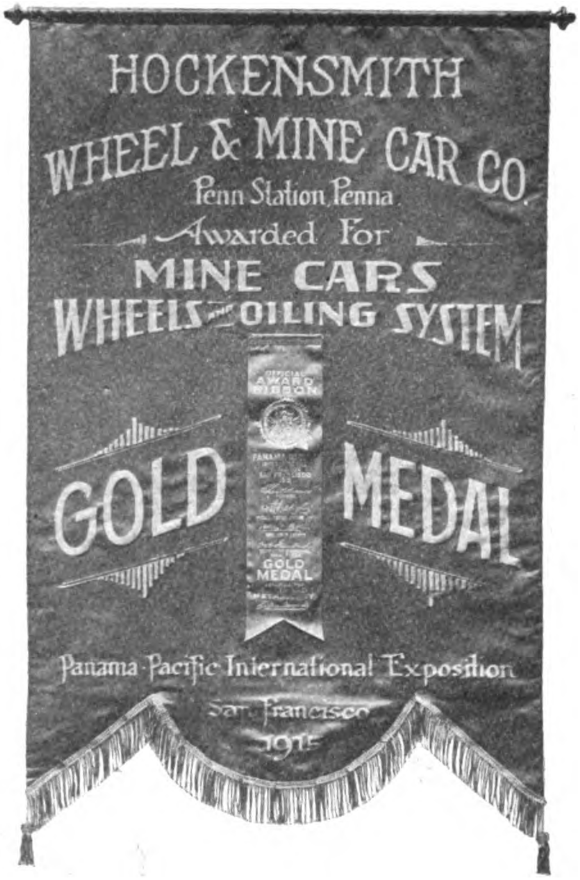
We point with pride to the fact that although this wheel has been on the market for six years and is now in use under the most severe conditions we have never been called upon to change the design. We maintain standards.

Angle Bar Trucks

This is the Truck that is strong where others are weak. There is placed across the car bottom two 6″ x 3½″ x ⅜″ angles, each of which are equivalent in strength to a 3″ square axle, but since the 6″ leg is placed next to the car bottom gives twice the bearing suface. This support to the bottom insures a full floating axle which in this construction is made of Cold Rolled Shafting, full section throughout and can be removed in case of accident without taking off boxes or turning car over. Two bolts in addition to a small projection pass through the angle while two larger projections are forced into the wooden bottom. The insertion this construction we are enabled to use wheels vent their coming together due to sudden stoppages, etc., with the strap which ties the angles, preventing their spreading due to action of brakes, etc., isures an absolute rigidity to the boxes which in turn results in a permanent wheel base. With this construction we are enabled to use wheels having a hub length of 7″—the center line of the hub being coincident with the center line of the load, so that we are enabled to obtain a balanced bearing. This Truck eliminates repairs, "wobbly cars" and cut-out wheels. Can be used upon any type of car and adapted to any style of wheel. When minimum height of car is desired we use and recommend our Double Angle Trucks, which arrangement places angles close to bottom of car.

The style of mine cars is determined entirely by local conditions. We can construct cars either from your design or upon receipt of sufficient information will be glad to submit ours. The Composite Steel Car which we show in the illustration is one of eight hundred built for one company. The side of this car is composed of ¼″ steel flanged plate, bolted to the car binder, which construction follows that usually employed in the construction of wooden cars. The bottom is of 3″ White Oak. The Latch is our "Correll" design which can be automatically opened and is self-closing. This car incorporates our Angle Bar Truck Construction with Hockensmith-Hyatt Roller Bearing Wheels.

We can construct all steel cars either bolted or riveted, or any type of wooden car.



Sheaves

The Sheaves manufactured by us are made from the same high grade strong iron that is used in our mine car wheels. We make the rope sheave either with a plain groove or rope lined groove. Bell sheaves are made either with or without stands and have chilled wearing faces.

We were awarded the Gold Medal—highest award—at the Panama Pacific Exposition, on our Wheels, Oiling System and Cars. All that goes to make up a Dependable Car.

Catalogues

Our latest Catalogue illustrates and describes our products more in detail and we would be glad to send this to you upon request.

LOBDELL CAR WHEEL COMPANY

ESTABLISHED 1836

WILMINGTON, DEL.

Steel and Iron Founders and Machinists

Eighty years of successful manufacturing of car wheels is the history of the Lobdell Car Wheel Company.

The beginning of the Lobdell Car Wheel Company was practically coincident with coal mining in America. And the company has grown and developed with the coal mining industry.

Mere magnitude means nothing, but the magnitude of this Company, one of the largest engaged in the car wheel business, has been due entirely to the superiority of its products.

Nor does mere age mean anything. The age in the case of this Company means experience, knowledge, progress. Every product of the Lobdell Car Wheel Company represents the highest achievement in its particular line—the highest achievement in design, the practical limit in quality of materials and accuracy of workmanship.

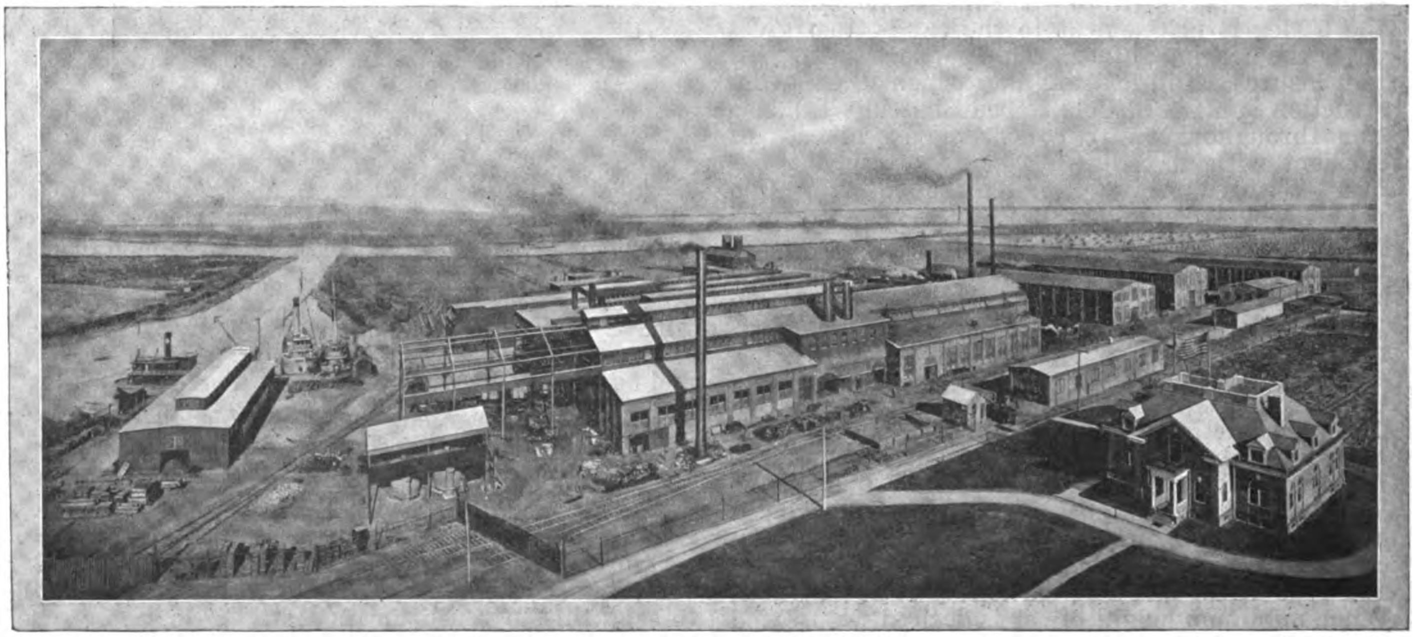
There are as many grades of chilled cast iron as there are of any other material. And the factors which produce the high grades are experience and knowledge and well-defined standards.

Needless to say, the plant must be modern in every detail. In all of these respects the Lobdell plant is unique. And in it are employed apparatus for the production of fine chilled iron which have been specially constructed to meet the Lobdell demand for the production of material of extraordinary strength and hardness.

There are no cheaper wheels than Lobdell Wheels. There are some that can be bought at lower prices, but this Company has never allowed itself to be tempted to meet low-price competition by any reduction of quality.

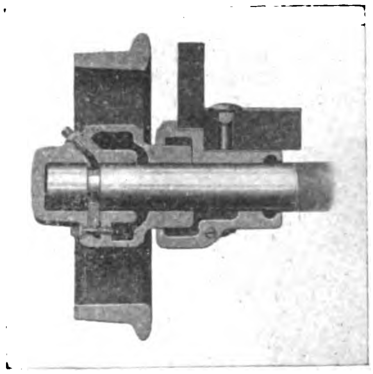
The Lobdell Company is fully equipped to make wheels of any description, furnishing either the wheels, axles, pedestals complete, or the wheels only suitable for use with axles already installed.

A very interesting and valuable catalog descriptive of the various types of wheels made in the Lobdell plant is to be had for the asking. The enormous variety of patterns and the diversity of types preclude the publishing of all this information in a condensed catalog of this kind.



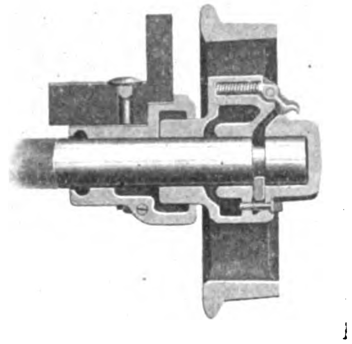
Long experience, however, permits the recommendation of the following types as being the most efficient in their respective classes:

The "Faught" Closed-Hub Self-Oiling Wheel

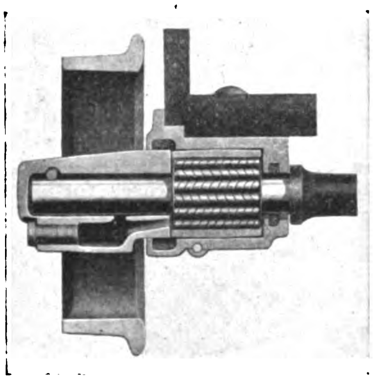

The "Faught" Closed-Hub Self-Oiling Wheel.

This is the most satisfactory wheel of this type made. It is easily and securely fastened on the axle. It has a solid closed hub—no expensive gaskets or leaky wheels. The lubrication is the best to be obtained in this type of wheel—the generous oil cavity holds enough oil to last several months. The extra long wheel bearing (8" evenly balanced) insures against worn hubs and wobbly wheels. The quality of the workmanship and material is the usual Lobdell standard.

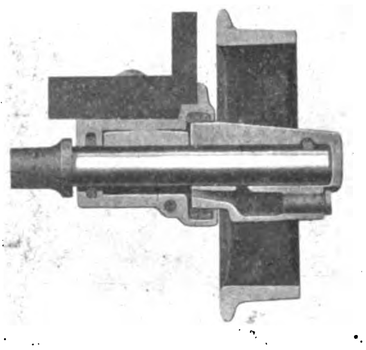
The "Faught" wheel is used extensively in many coal and metal mines in Cuba, Central America and all parts of the United States.


Spring Trigger Wheel.

The "Lobdell" Tight and Loose Wheel Hyatt Roller Bearing Equipment


Roller Bearing.

This is the most scientific use of the roller bearing in mine car equipment. The roller bearings are mounted in self-aligning steel sleeves in the pedestal casting by which method they are absolutely relieved of any uneven wear due to thrusts from the rail against the flange. The demands for high speeds and heavy loads incident to modern, up-to-date mining operation are met in this equipment which can be furnished with iron or brass bearings instead of the steel sleeve and rollers if preferred. It is particularly recommended for use under heavy cars requiring axles 2¾" in diameter and over.


Brass or Iron Bearing.

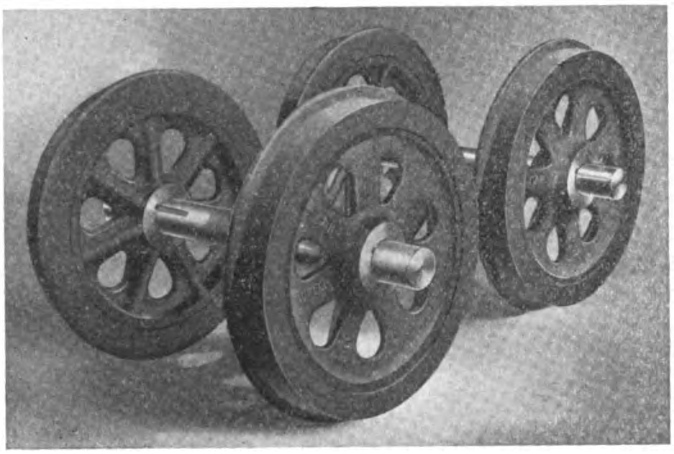
MINING LOCOMOTIVE WHEELS

Lobdell Chilled Iron Wheels

Meet the severe requirements of this service perfectly. The great superiority of the Lobdell casting and annealing processes enables the production of wheels whose great economy lies in their extraordinary length of good service.

Steel Tired Wheels

The Lobdell standard is maintained in the production of these wheels. The materials are the best obtainable for the purpose, and the tires and centres are both machined accurately to standard gauges. Loose tires will be furnished properly bored for refitting on to the old centres.



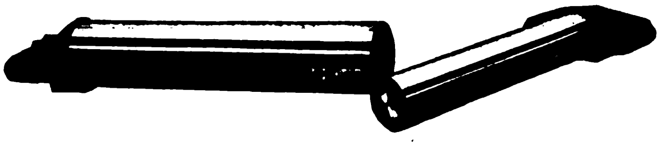
Lobdell High Carbon Heat Treated Solid Steel Wheels

Offer considerable economy in first cost over the steel tired wheels, having the same advantages of increased tractive power, flange strength, etc.

Lobdell Wheels in any of the above types are furnished for almost any make of mining locomotive (Jeffrey, General Electric, Goodman, Baldwin-Westinghouse, Morgan-Gardner, etc.). This Company is thoroughly equipped with patterns and makes a specialty of refitting such wheels on either old or new axles.

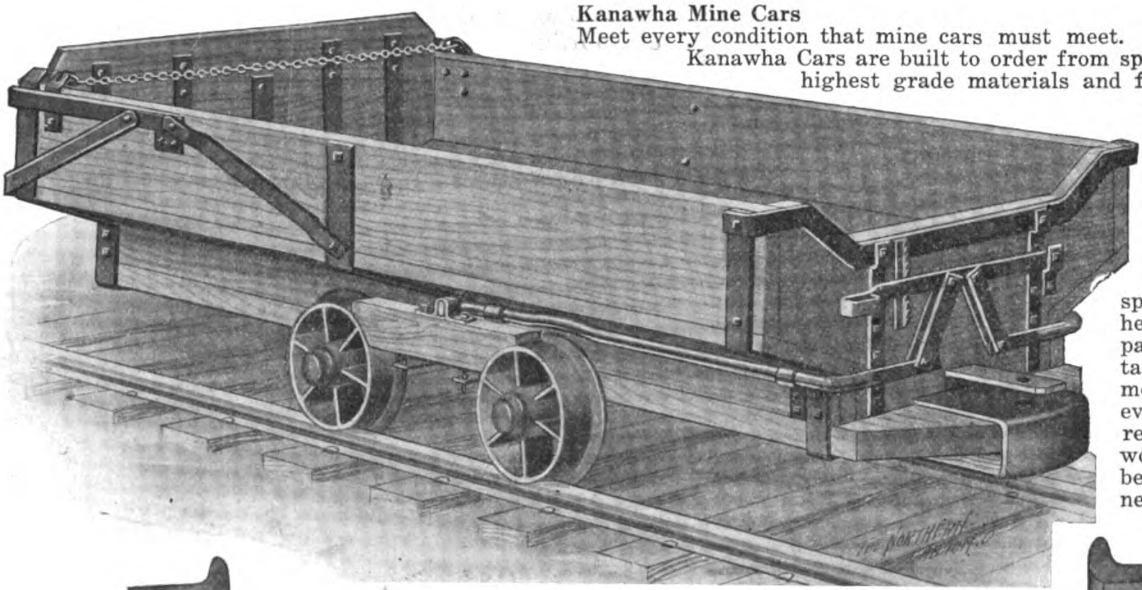
CHILLED IRON PUMP PLUNGERS

Chilled iron pump plungers have a hard chilled surface, accurately ground and highly polished, which will positively not score. The packing on pumps equipped with Lobdell Chilled Iron Plungers has been known to last for several years and the saving in packing usually very soon pays for the cost of the plungers. These plungers can be furnished for any style pump now using grey iron or copper-jacketed plungers.

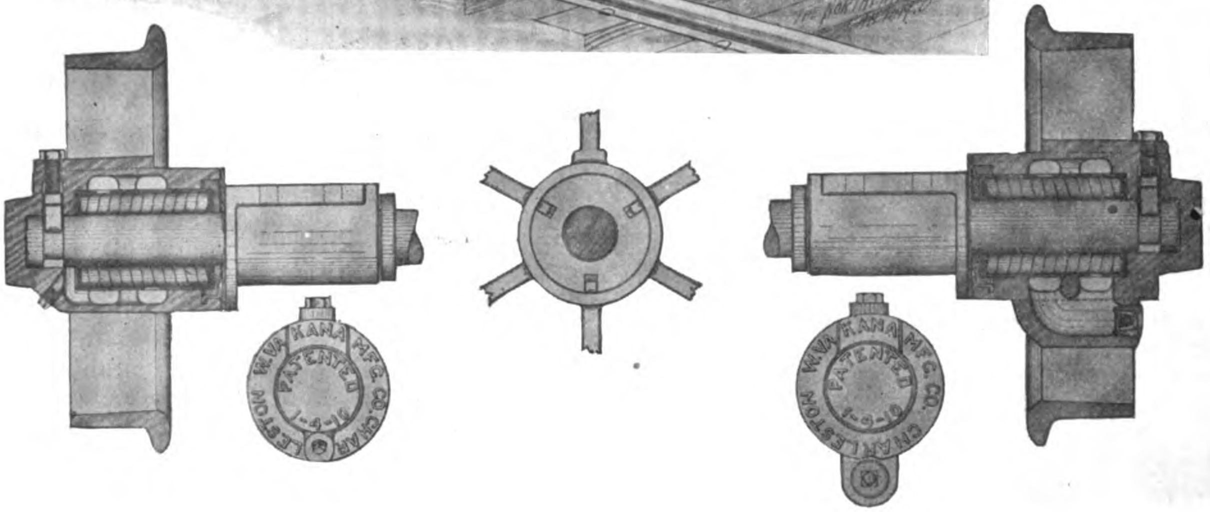

Chilled Iron Plungers.

KANAWHA MANUFACTURING CO.

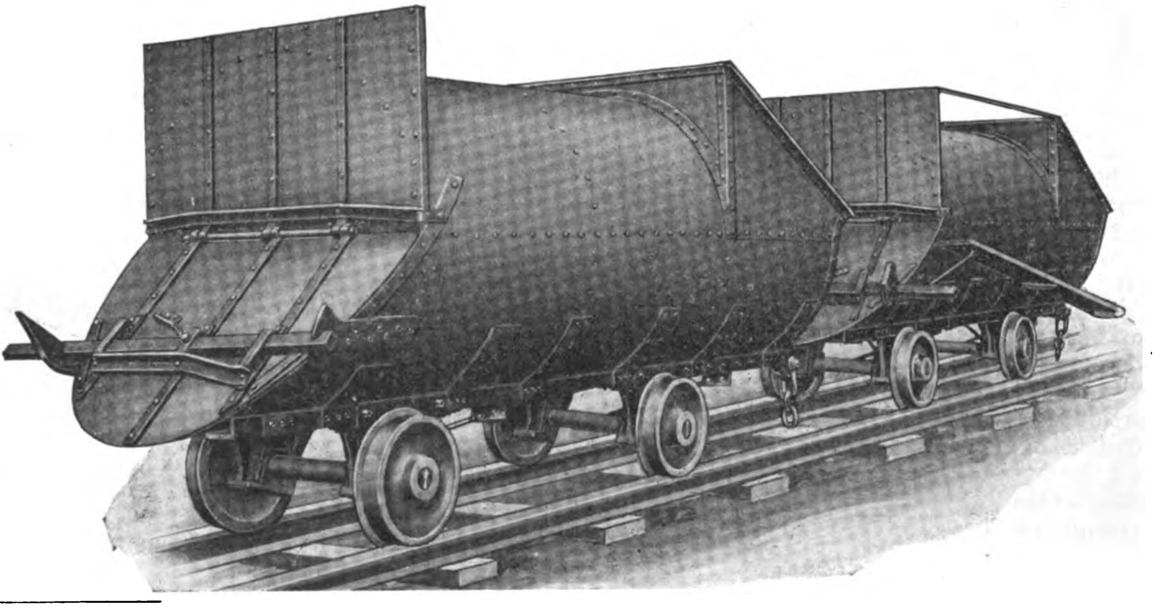
CHARLESTON, W. VA.



Kanawha Mine Cars
Meet every condition that mine cars must meet. THE REASON—Kanawha Cars are built to order from specifications, of the highest grade materials and for the best interests of the user. As a result, a vast number of operators are now buying Kanawha Cars exclusively. Every operator recognizes the need of special adaptions in height, width, capacity and other details. Efficient roadmen, practical in every sense, are ready to help you work out the design best suited to your needs.


W. VA. KANA. MFG. CO. CHARLESTON
PATENTED
1-9-10
W. VA. KANA. MFG. CO. CHARLESTON
PATENTED
1-9-10

Kanawha-Hyatt Roller Bearing Wheels
give the maximum of efficiency in durability, ease of running and in economy in oil and repairs. These wheels soon pay for themselves in oil saved. Each wheel holds a full quart of oil, enough in all cases for eight to twelve months running.



OTTUMWA IRON WORKS, Inc.

OTTUMWA, IOWA.

Manufacturers of

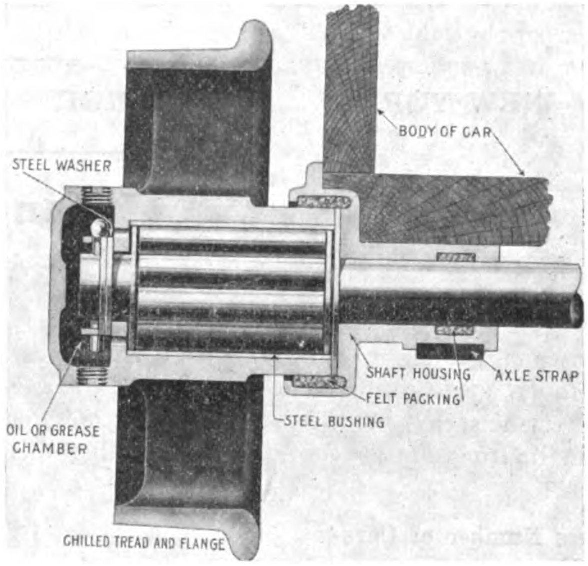
Ottumwa Iron Works Roller Bearing Car Trucks

The Ottumwa Iron Works has been in the business of manufacturing Mining Machinery for over 50 years. The development of our roller bearing wheels is the result of the accumulated experience of all these years in the manufacture of car trucks. The time of the old type mine car wheel is gone, as all up-to-date Mine Operators recognize the economy and efficiency of the roller bearing wheels.

While the initial cost is more than was formerly invested in the old type wheels, the reduction in power necessary to operate the cars and saving in grease greatly overcomes the difference in price.

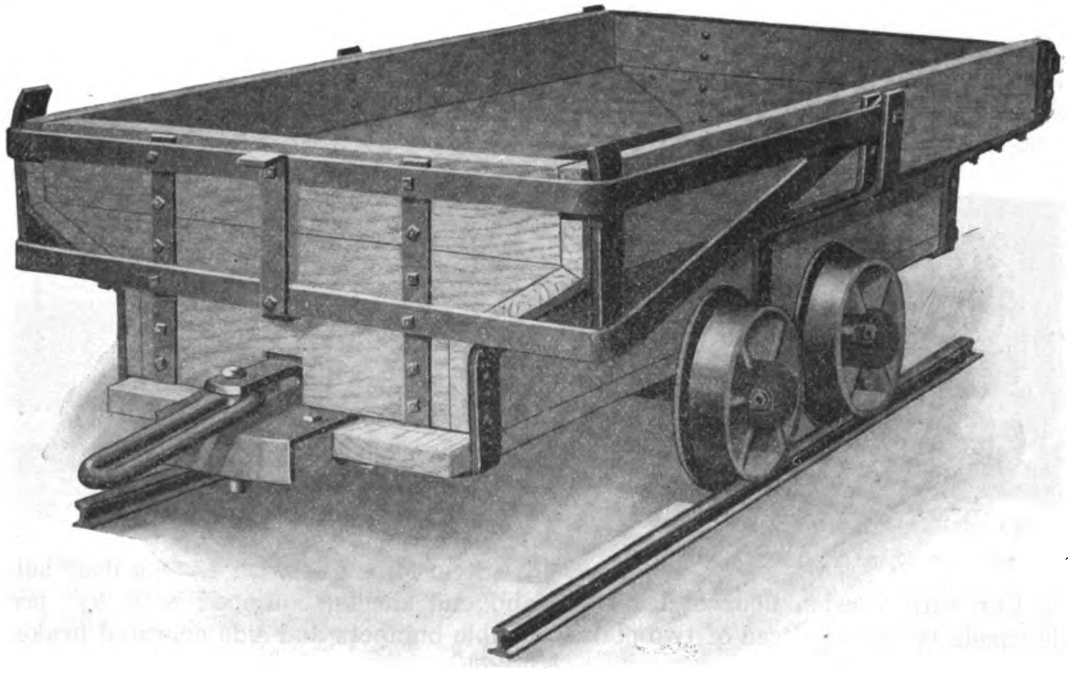
Ottumwa roller bearing car trucks are equipped with floating axles so that there is no wear on any given point as is the case with the old type fixed axle.

Ottumwa wheels are made of the highest grade material for wheel purposes. The wheels are thoroughly chilled and afterwards annealed. The design and composition of the wheel is the result of years of experience and study, which accounts for the continually increasing volume of our business in this line.



In writing for quotation specify
- Diameter of wheel
- Track gauge
- Wheel base
- Size of axle or
- Maximum load the trucks are to carry.

All inquiries will receive prompt attention.



PRESSED STEEL CAR COMPANY

Builders of

MINE AND RAILROAD CARS

General Offices

Farmers Bank Building
Pittsburgh, Pa.

Works

Pittsburgh, Pa., McKees Rocks, Pa.,
and Hegewisch, Ill.

Sales Offices

NEW YORK PITTSBURGH CHICAGO WASHINGTON, D. C.

Mine Cars

Steel Mine Cars
are becoming more popular every year with mine owners on account of their strength as compared with wooden cars, the greater capacity obtained within limiting dimensions and their lasting qualities.

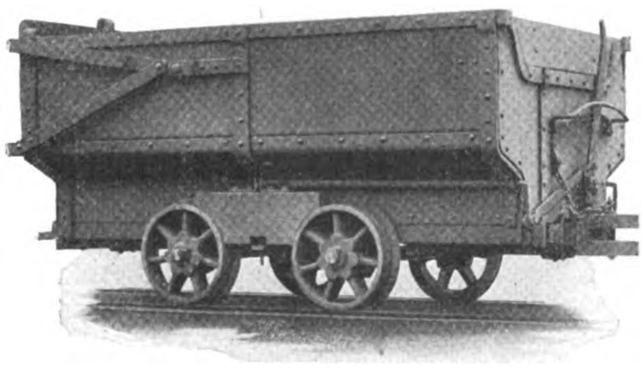
A Less Number of Cars
are required to operate a mine of a given output, as fewer cars are out of service on account of repairs.

The Economical Operation
of mines is a point of vital importance to mine owners, and in spite of the fact that the first cost is somewhat greater the steel car is much less expensive in the long run.

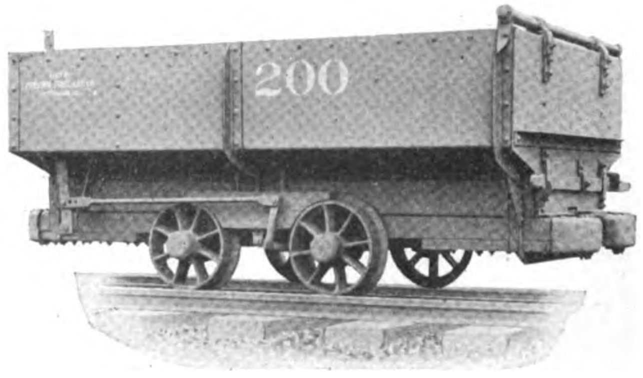
The Pressed Steel Car Company's
experience in this line is of long standing, and the many thousands of mine cars turned out by them are, without exception, giving entire satisfaction.

Special Attention
is called to the fact that this Company is in position to build Steel Mine Cars of any design or construction which may be desired. We are always glad to send our representative to go into the question of designs, or these can be prepared from blue prints showing the cars at present in operation, or upon receipt of detailed descriptions of the cars desired, including limiting dimensions, etc.

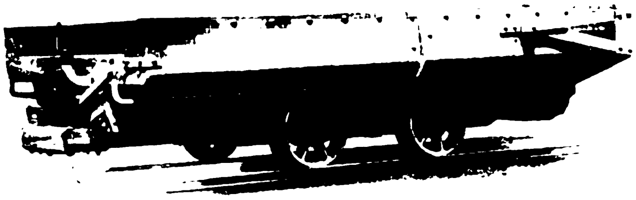
Attention is invited to the illustrations below and on the opposite page, which show a few of the various cars built by this Company recently.



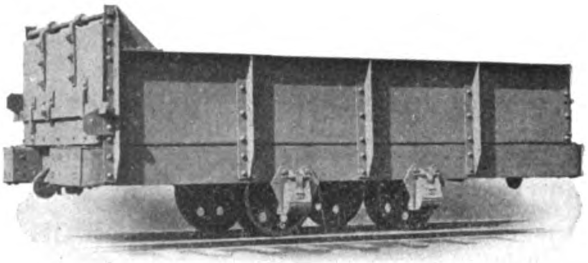
Steel Mine Car with wooden floor and spring drawbars, side sheets being composed of two plates either riveted or bolted together.



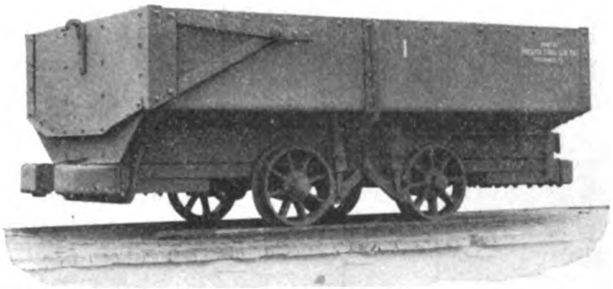
Steel Mine Car with 4" Oak floor bolted to side and end sheets, equipped with ½" pressed steel double bumpers and side operated brake applied to all wheels.



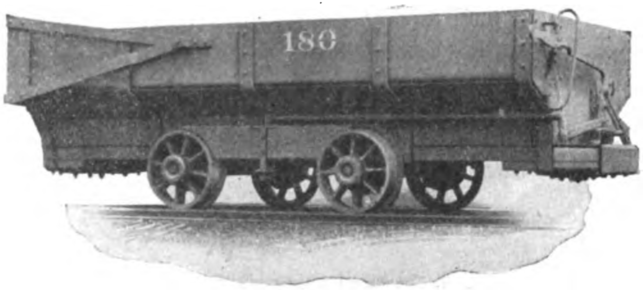
All Steel Mine Car with steel floor and removable wooden bumper cushions. This construction permits a very low car with large capacity.



All Steel Mine Car constructed of steel plates and rolled shapes arranged so that any damaged parts can be easily replaced at the mines. Equipped with waste packed journal boxes.



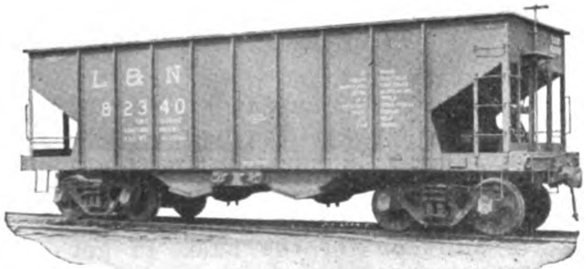
A Steel Car of the double or side bumper type, with wood floor. Equipped with an all-metal brake arrangement and self-oiling wheels. Wood Block Brake Shoes can be substituted for the all-metal brake shoes if desired.



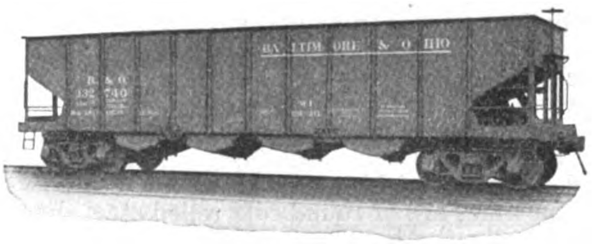
Steel Mine Car with wooden floor of the pieced or bolted type, each side sheet being composed of three $\frac{1}{4}''$ steel plates bolted together in order to facilitate repairs.

Freight Cars

In addition to the manufacture of mine cars, The Pressed Steel Car Co. is one of the largest builders of freight and passenger cars in the world, being the first Company to engage in the manufacture of steel cars, and the long experience in this line of work, together with the experienced force of engineers and the large capacity of its plants, enables it to take care of the largest as well as the smallest consumer of either mine or railroad cars.



Self-Clearing Hopper Car.
Standard Type of Center Dumping Coal Car.
Capacity, 110,000 Pounds.



Quadruple Hopper Coke Car.
Combined Door Opening, 94 Sq. Feet.
Capacity, 110,000 Pounds.
Cubic Contents, 2,792 Cubic Feet.

Write for Special Circulars.

Phillips Mine & Mill Supply Co.

ESTABLISHED 1863.

Pittsburgh, Pa.

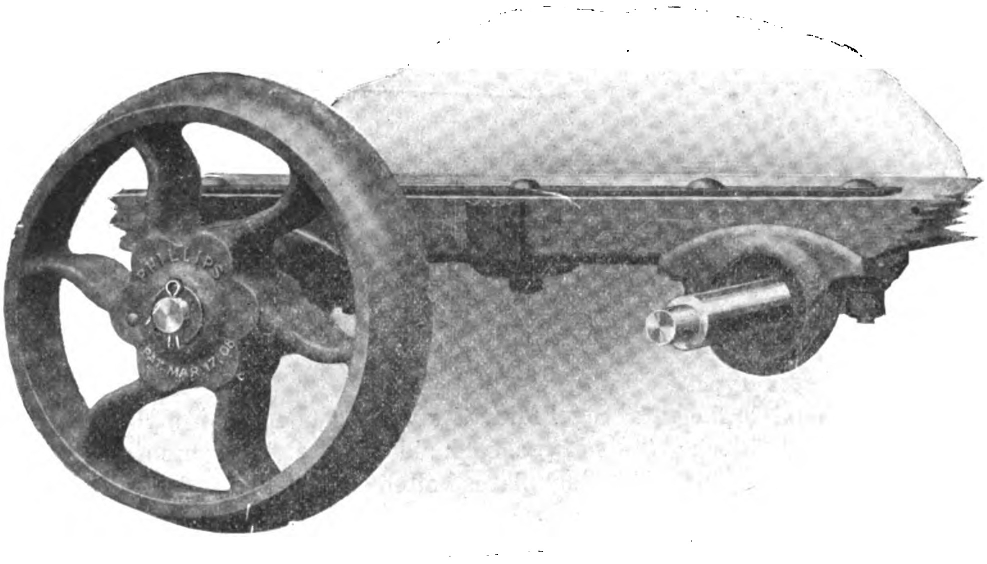
Mine and Coke Works Equipment

Agencies:

SEATTLE: A. F. Blair, C. & M. E.
HUNTINGTON, W. VA.: MILLER SUPPLY CO.
LETHBRIDGE, CAN.: J. B. Turney & Co.

Products

Mine Cars, Mine Car Wheels, Mine Car Trucks, Screens, Screen Bars, Screening Equipments, Larry Wagons, Cast Iron Frogs and Turnouts, Automatic Car Stops, Caging Machines, the Phillips Automatic Cross-Over Dump, the Phillips Automatic Push-Back Car Dump, etc.

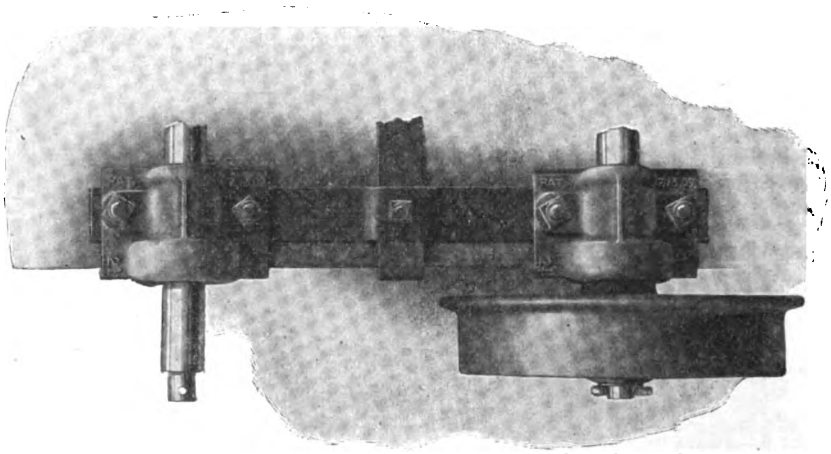


The Phillips Patent Open Cap Wheel Truck is one of our products. It is extremely simple in design, has no elaborate internal or external construction which requires care and close watching in order to obtain results, and has no loose or projecting parts to get out of order, knocked off or lost. The linch pin is always visible, and if lost or broken a new pin can be provided before damage results. A feature which especially appeals to the car builder or carpenter is that only 10 bolts are required to assemble the truck on the car—experience has proven that a few large bolts are more effective than many of smaller diameter, and the work of assembling and repairing can be done more quickly.

The axles are of round cold rolled steel shafting, and turn in the boxes to distribute the wear over the entire surface of the axle journal. The collar on the axle is on the INSIDE of the wheel where it runs continuously in oil; it maintains the wheels to gauge and prevents sideways play, doing the same work as the projecting collar on the ordinary axle, but without the frictional resistance present in the old style construction.

Severe tests have shown that the drawbar pull on cars equipped with the Open Cap Truck is fully 25% less than with the regulation self oiling wheels, in fact, the Open Cap Wheels run so easily that the comparison with roller bearing equipment is not at all unfavorable, they eliminate wheel trouble and give longer service. With non-fluid oil, or mine car grease, the wheels have run as long as 27 months with one lubrication, but we recommend lubricating the wheels every six or eight months. The truck is guaranteed for a year against internal wear in the wheels and journal boxes, and equipment which has been in service for 10 years shows no perceptible wear internally.

The illustration of the bottom of the car shows the steel straps connecting the journal boxes. These straps are placed both over and under the floor, tie the boxes together longitudinally, and are of sufficient weight that they will not rust out as quickly as structural shapes. This construction is positive and permanent, and 10 years experience has shown that it is impossible for the boxes to shift or for the axles to get out of alignment.



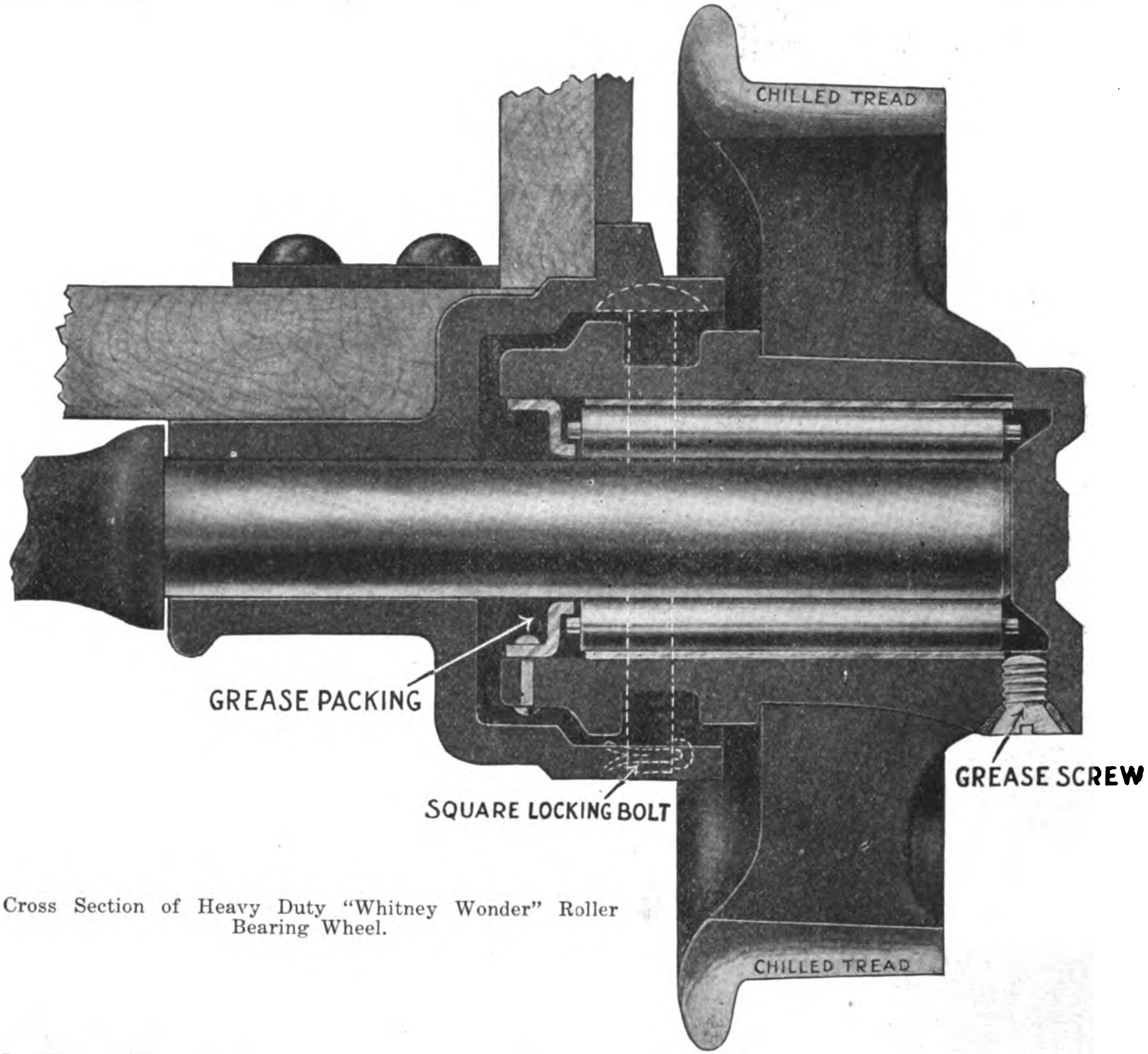
These trucks can be furnished in all the usual and desirable combinations as regards track gauge, wheelbase, diameter of wheel and axle, weight of wheel, etc. Will be glad to furnish full particulars, drawings and prices on request.

SANFORD-DAY IRON WORKS

Main Office and Factory: Knoxville, Tenn.

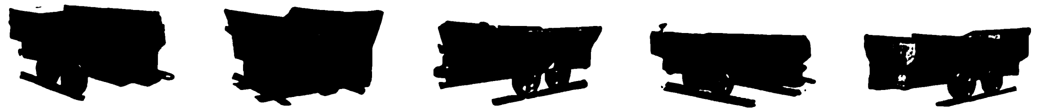
Branches
BIRMINGHAM, DENVER, NEW YORK SALT LAKE CITY.

Our big loose leaf catalog No. 25-K—160 pages of wheels trucks, cars, sheaves, rollers, drums, couplings, dumps, screens, etc., is by far the most complete and handsomest catalog of its kind ever published and should be in your files.

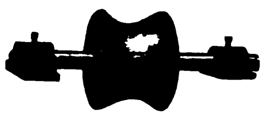


Cross Section of Heavy Duty "Whitney Wonder" Roller Bearing Wheel.

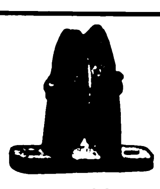
The Whitney Wonder is the pioneer roller bearing wheel. It is the simplicity of genius. This patented wheel is in wider use than any other roller bearing wheel on earth. It is in a class by itself. It is fool-proof and practically indestructable. Holds grease 12 to 18 months. Makes a mine car run like an automobile.



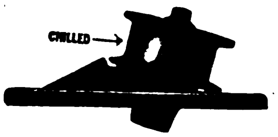
We make cars.



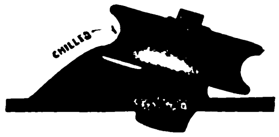
Style No. 1-A.



Style 2-D



Style 4-F



Style 4-H

All kinds sheaves.

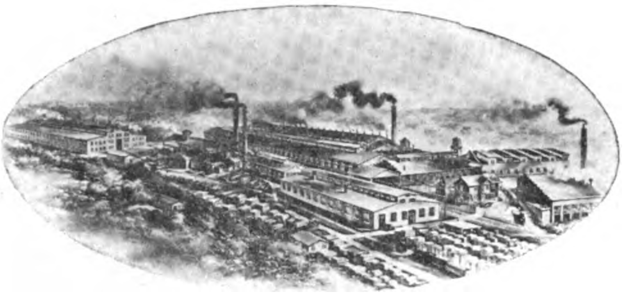
THE WATT MINING CAR WHEEL CO.

BARNESVILLE, OHIO, U. S. A.

SAN FRANCISCO
N. D. Phelps

DENVER
Lindrooth, Shubart & Co.

WATT



WATT

Our Factory

We show above a bird's eye view of our car works, which is the largest and most efficiently equipped plant in the world devoted exclusively to the manufacture of mining cars. We hope that some day we may have the pleasure of showing you through these great car works.

Profit

The saying is true—"The margin of your profit and the volume of your output depend largely upon the efficiency of your equipment." With this idea in view we built our plant and now use it to build efficient equipment for your mine.

Design

Our engineers are certainly competent of designing your equipment as they have specialized in this work alone. We are sure they can offer you some valuable suggestions, which are free for the asking and will not obligate you in any way.

Stock Cars

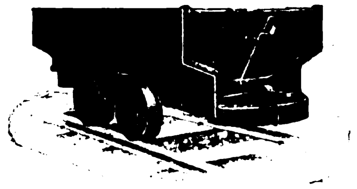
The cars shown on this and the opposite page are not stock cars but are of special design, worked out to meet certain conditions.

Why Special Designs?

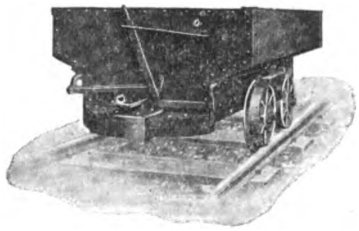
Every mine has its different track gauge, the car must have a certain capacity—heights and widths not to be exceeded—certain features in regard to the door, latch or brake and many other changeable items, thereby making it impossible to carry a stock car that would answer your requirement.

Suggestions For You

In looking over these cars you may find one which would be ideal for your mine however our intention is more to present ideas to you. If you desire full particulars about any of them, write us mentioning the number and we will gladly furnish them.

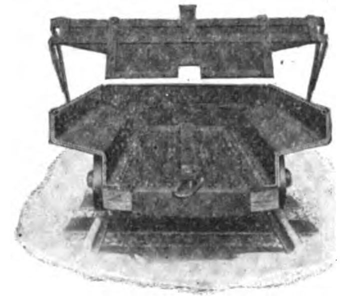


K-1. Steel car with wood bottom, swing door and double end brake.

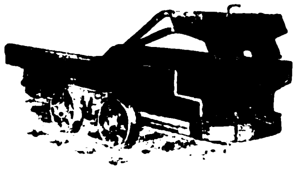


K-2. This is a rear view of car K-1 and shows the position of the double brake.

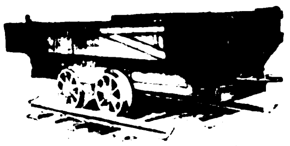
K-3. Low Vein car, lift bail door, double end brake with steel brake shoes. End is cut low to facilitate the loading.



K-4. Steel car, wood bottom, lift bail door. Note the door on rear end for loading in low coal. Watt Brass Bushed Wheels are used.

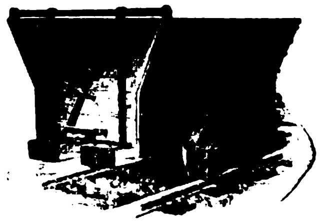


K-5. Another view of car K-4. It shows the single end brake.



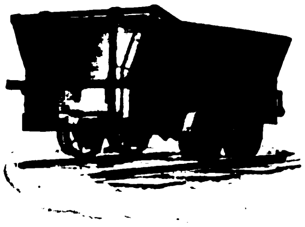
K-6. This car is practically the same as car K-5 except you will note different construction on the door.

K-7. A steel car with bail lift door, chain across top, single end brake on left hand side.

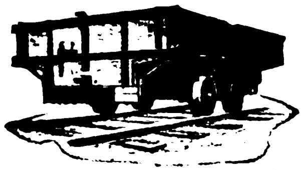


K-8. This is the common flare car with swing door, side bumpers and single end brake.

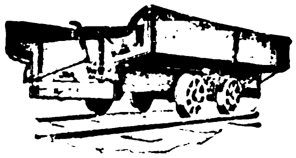
K-9. An all steel car for low vein coal. Swing door with latch and chain hook fasten. Double end steel brake.



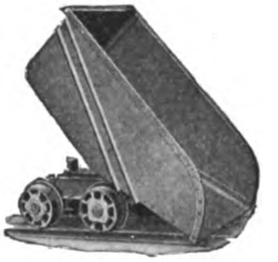
K-10. This is another type of flare car used for clay or coal. Has swing door, bar latch fasten, side bumpers and single end brake.



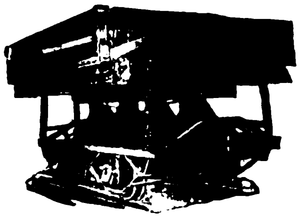
K-11. A wood car of popular construction, lift door, center bumpers, double end brake. Note the braces under the binders for strength.



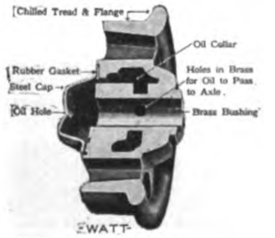
K-12. This is an end view of car K-11 and will show you the brake construction.



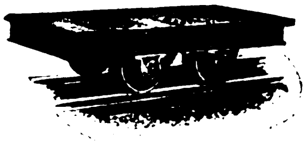
K-13. A refuse car can be dumped in any position. Good for slate, gravel, ashes and etc.



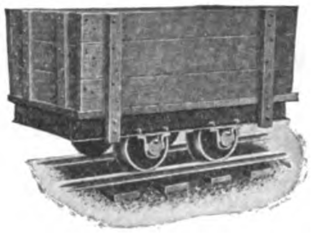
K-14. A two way dump quarry car. Suitable for steam shovel loading. Solid wheels and outside brass bearings.



K-26. The Watt Brass Bushed Wheel. This cut shows the cap type—it is also furnished without the cap. When bearings are worn—can be replaced—giving you practically a new wheel.

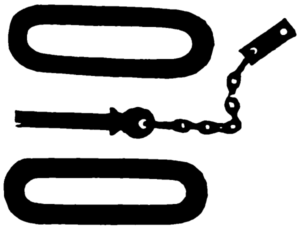


K-15. A very popular truck used for most any kind of hauling. Has solid wheels with outside roller bearings.

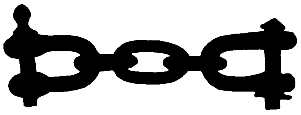


K-16. Truck K-15, is so constructed that with a few quick changes you can form this truck. Write for information on how to form two trucks from truck K-15.

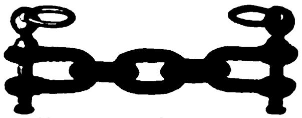
K-17. An all steel car with lift door. Note the door in the end to facilitate the loading. Has a double end brake.



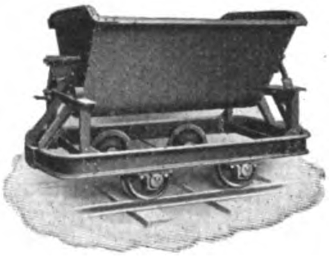
K-18. This is the standard loose pin and chain and coupling link. Lower link is made of square bar and the upper of round.



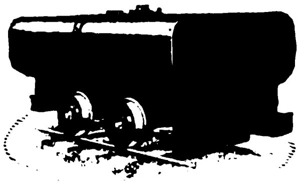
K-19. The clevise and three link coupling. One pin is fastened tight with a cotter and the other is loose for the releasing of link.



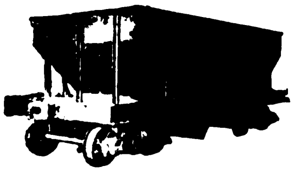
K-20. This is the most popular coupling of today. Both pins are provided with a ring for their lifting. Both pins are swelled on the ends, making it impossible for them to be removed.



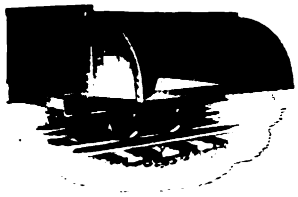
K-21. A rocker car with solid wheels and outside roller bearings. This car can be used for most any kind of dumping.



K-27. A steel water car. Very neat looking and is an excellent water car. It is equipped with Watt Brass Bushed Wheels

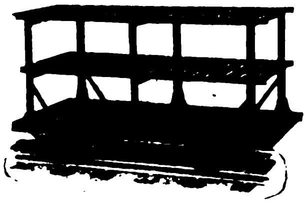


K-22. The construction of this car is the same as used by the railroads in making their all steel hopper bottom cars. This car is three-quarter size.

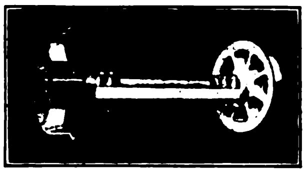


K-23. A charging car. Shows door down for unloading. Has solid wheels and outside roller bearings.

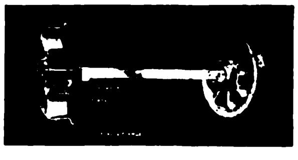
K-24. This car will dump in most any position. Can be used for stone, gravel, slate and etc.



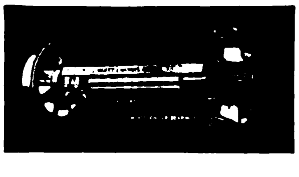
K-25. A triple deck dryer car. Is constructed of light angles and bars, has solid wheels and outside roller bearings.



K-28. This is the standard Watt plain bearing truck with capless wheels. On careful examination it will show you the construction.



K-29. This is another type of Watt plain bearing trucks. Wheels are of the cap type and square axles are used.



K-31. This truck is known as the Watt-Hyatt roller bearing truck. Note that the wheels have an end screw plug to allow the removing of the bearings. The plugs cannot work loose as they are held tight with a set screw.

THE STAR MANUFACTURING CO.

NEW LEXINGTON, OHIO, U. S. A.

Manufacturers of

Wood and Steel Mine Cars, and All Wood Mine Pumps

The Big Outstanding Feature of Star Mine Cars Is the Self-Oiling, Dust-Proof Wheel Bearing

It is a fact that the other features are equally important. In fact, equally essential.

While it is true that most forms of truss construction are generally good, nevertheless there are distinct advantages to be secured from the Star truss construction. Among them, the absolutely constant, rigid strength of the special construction which asorbs and breaks shocks and withstands heavy overloading.

The big fact remains, however, that Star **Mine Cars alone have the self-oiling, dust-proof bearings** in the wheels. And upon this feature the **largest users of mine cars in the United States have placed their confidence.** And they continue to place repeat orders regularly, at the same time praising and recommending Star Mine Cars and Wheels.

Write for our mine car Catalog. It describes our self-oiling plain bearing and also our highly developed and efficient roller bearing. Also types of Cars, Details, Prices, etc.

The distinct advantages of roller bearings are larger loads with less power.

We are located in the heart of the coal mining district on the Pennsylvania and New York Central railroads.

With our new buildings and equipment we have tripled our output and are able to make prompt shipments.

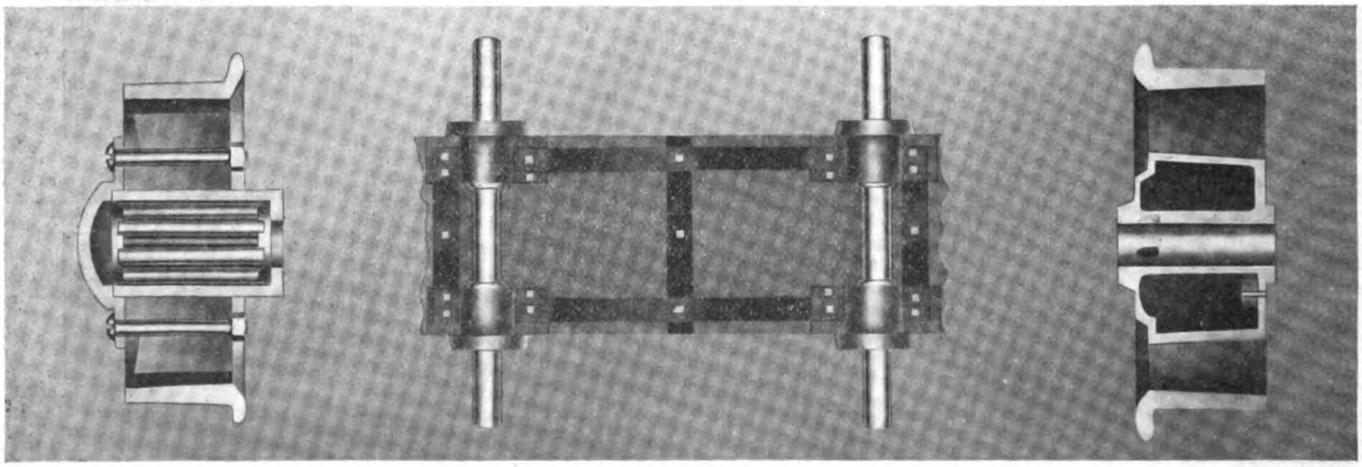
We make steel or wooden cars complete.

Products

We build Mine Cars, Ore Cars, Quarry Cars, Contractors Cars, Dump Cars, both wood and steel to any specifications.

WRITE FOR OUR FREE CATALOG TODAY.

The Self-Oiling Dust Proof Bearing is shown on the right.
The special truss construction of Star Mine Cars is shown in the center.
The efficient Star Roller Bearing for Mine Car Wheels is shown on the left.



YOUNGSTOWN STEEL CAR CO.

General Offices and Works
YOUNGSTOWN, OHIO

NEW YORK
PHILADELPHIA

Sales Offices
SAN FRANCISCO

SEATTLE
SALT LAKE CITY

Designers and Builders of

Steel Mine Cars

Products

Standard, special steel, and composite mine cars of all descriptions built to customer's specification. We build cars with side, end dump or for rotary dumps, and with plain, self-oiling or roller bearing wheels. "Youngstown" special self-aligning roller bearings. Mine car trucks and angle irons. Steel tipples designed and constructed.

Shop and Location.

The present capacity of our shop is twenty-five standard mine cars a day, and is being constantly increased to meet additional demands. We employ only the most skilled workmen, many of whom have been in our employ from sixteen to twenty years. We are located in the center of iron and coal production on five important trunk lines and we can give you most prompt deliveries.

Send at once for our mine car bulletin.

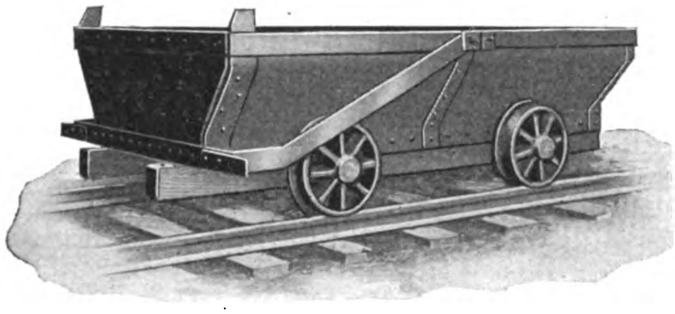


Fig. 1033.
Steel Body Quarry Mine Car, with Left Door.
81 Cu. Ft. Capacity. 48 in. Gauge.

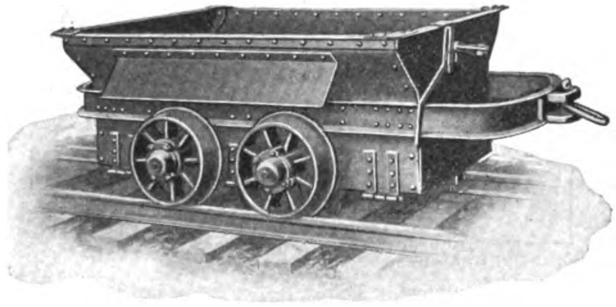


Fig. 1034.
All-Steel Hopper Bottom Mine Car. Height Above Rail 2' 6".
40 Cu. Ft. Capacity. 42 in. Gauge.

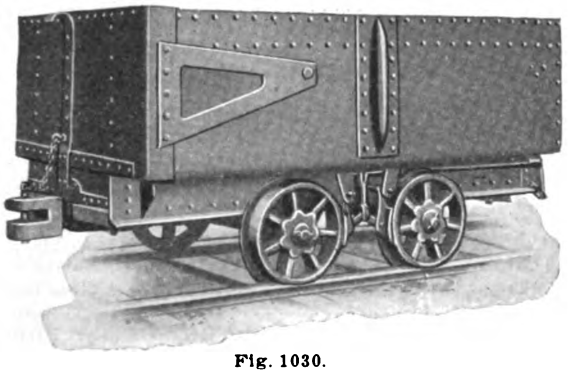


Fig. 1030.
Composite Mine Car, Spring Draft Gear.
100 Cu. Ft. Capacity. 48 in. Gauge.

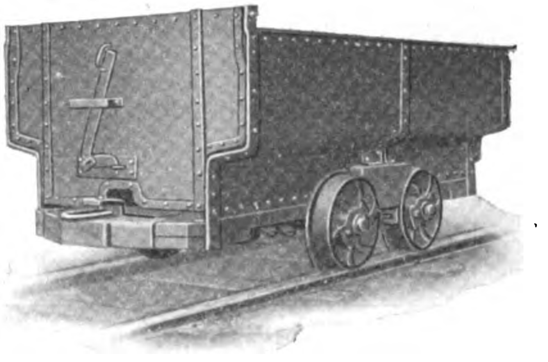


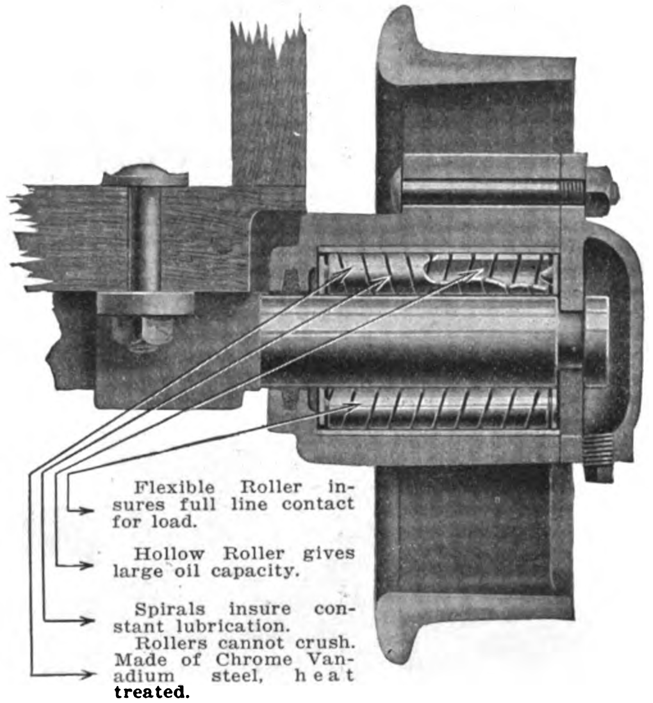
Fig. 1022.
Composite Mine Car, Reinforced Bumper.
84 Cu. Ft. Capacity. 44 in. Gauge.

HYATT ROLLER BEARING CO.

NEWARK, N. J.

Hyatt Bearings for Mine Cars

The power saving features of the Hyatt Roller Bearings has been considered to be of such importance that we constructed a dynamometer car equipped with scientific recording instruments that would definitely determine the reduction in power requirements made possible by the use of the Hyatt equipped mine cars. Accordingly, such tests were made and the results were graphically and accurately recorded.


Flexible Roller insures full line contact for load.
Hollow Roller gives large oil capacity.
Spirals insure constant lubrication.
Rollers cannot crush. Made of Chrome Vanadium steel, heat treated.

Installation Showing Hyatt Roller Bearings in Wheel Hub.

The test conducted at the Greensburg Coal Company's mine at Greensburg, Pa., in co-operation with the H. C. Frick Coke Company was made with two trains of twenty cars each. One train was composed of plain bearing cars, while the other consisted entirely of cars equipped with Hyatt Roller Bearings. The cars used in both trains were identical in every respect with the exception of the bearings. Three tests were made with each train of cars and the average of all readings was as follows:

GREENSBURG TEST RESULTS

Type of Bearing	Average Drawbar Pull Per Ton on Level	Average Speed	Average Grade	Weight of Train
Hyatt	12.8 lbs.	5.98 miles per hour	2.4%	71.5 Tons
Plain	24.3 lbs.	5.59 miles per hour	2.4%	71.5 Tons

Another similar test was conducted later on at the Coalbrook Colliery of Delaware and Hudson Company, at Carbondale, Pa. The two trains consisted of ten cars each and were identical in every respect except the bearings.

The results were carefully noted and averages taken were as follows:

CARBONDALE TEST RESULTS

Type of Bearing	Average Drawbar Pull Per Ton on Level	Average Speed	Average Grade	Weight of Train
Hyatt	13 lbs.	7.8 miles per hour	.45%	40.84 Tons
Plain	32 lbs.	8 miles per hour	.45%	41.44 Tons

These tests showed conclusively that the Hyatt equipped train saved 47.25% in power at the Greensburg test and nearly 60% at the Coalbrook Colliery test. This economy of tractive effort when measured in actual dollars and cents proves that the Hyatt Roller Bearing is an ideal dividend paying investment.

Hyatt Bearings are ruggedly constructed and are durable and dependable. They are made from a special analysis steel, which we have found from experience to be the best for the purpose. Bearings that have been in service for years—operating under the most severe conditions—are still giving successful service.

Hyatt Roller Bearings have made such remarkable service records that they have been adopted as a standard by many of the most prominent mine car builders, as shown below.

Coal Mine Car Manufacturers

Hockensmith Wheel & Mine Car Co.	Penn Station, Pa.
Kanawha Manufacturing Company	Charleston, W. Va.
Eagle Iron Works Company	Terre Haute, Indiana
Watt Mining Car Wheel Company	Barnesville, Ohio
American Car & Foundry Company	Berwick, Pa.
J. R. Fleming & Son Company	Scranton, Pa.
Enterprise Fdry. & Machine Wks.	Bristol, Virginia, Tenn.
Eagle Iron Works	Des Moines, Iowa
Lobdell Car Wheel Company	Wilmington, Del.

Metal Mine Car Manufacturers

Anaconda Copper Mining Company	Butte, Montana
Truax Manufacturing Company	Denver, Colo.
Lake Shore Engine Works	Marquette, Michigan
Joshua Hendy Iron Works	San Francisco, Cal.
American Car & Foundry Company	Berwick, Pa.
El Paso Foundry & Machine Co.	El Paso, Texas
Coeur D'Alene Hdw. & Fdry. Co.	Wallace, Idaho
Watt Mining Car Wheel Co.	Barnesville, Ohio
Kilbourne & Jacobs Mfg. Company	Columbus, Ohio
George Brothers	Grass Valley, California

We shall be glad to send any of our mine car bulletins—or any other data pertaining to your haulage problems—on request.

JAMES McKAY COMPANY

Established 1880

OFFICE AND WORKS

PITTSBURGH, PA. McKEES ROCKS

"QUALITY" FORGINGS

For Mine Cars and Mine Equipment

Registered

Registered

Products

Our famous Bell Design Clevises and Mine Car Hitchings are made from double refined Iron and by a special Forging Process which develops their maximum strength. Machine or service tests will convince users of their superiority over all others.

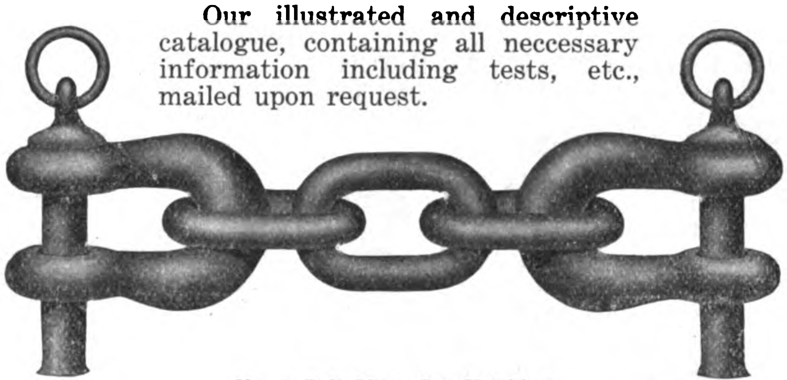
Our Dependable Puncher Picks and Bits are made from our own special Alloy Crucible Steel. This, together with our special process of manufacture enables us to offer the trade a product guaranteed to give longer and more uniform service.

Drop Forgings, Commercial and Special. We are equipped to handle any offering in this line from 8 ounces to 100 lbs. Steam hammered or pressed and scientifically heat treated when neccessary.

Quality Chains for all mechanical uses. Hand and machine made from Iron or Steel and guaranteed for the use intended.

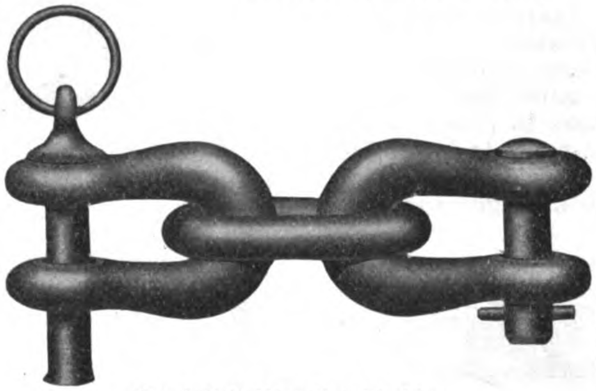
Special Iron and Steel; with 3000 tons in our yards, new and modern equipment, together with 36 years of continuous effort, enables us to offer products carrying the highest standard of efficiency and adaptability.

Our illustrated and descriptive catalogue, containing all neccessary information including tests, etc., mailed upon request.



No. 1 Bell Mine Car Hitching.

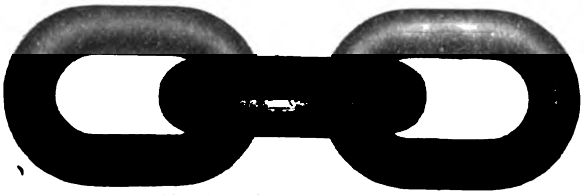
Octagon Puncher Pick.



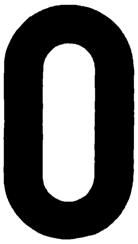
No. 5 Bell Mine Car Hitching.

No. 7 Link Hitching.

Forged Bits, all kinds.

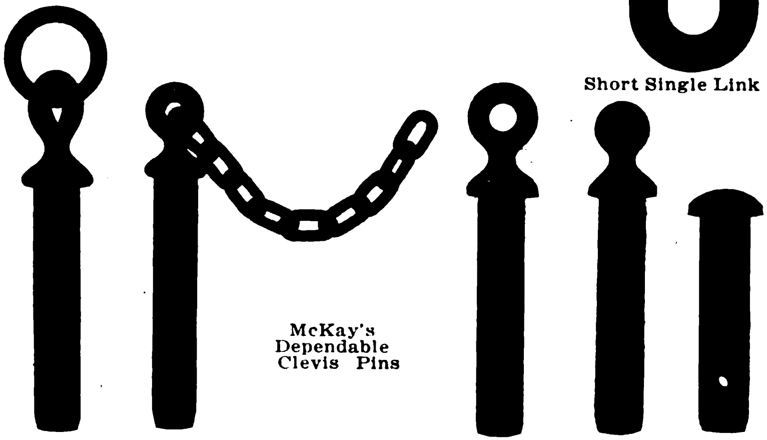


No. 6—3 Link Hitchings.



Short Single Link

Scraper Heads



McKay's Dependable Clevis Pins

Hitching Pins.

Investigate Our Special Puncher Pick and Bit Steel.

MACOMBER & WHYTE ROPE CO.

Main Office and Works
KENOSHA, WISCONSIN, U. S. A.
BRANCHES
CHICAGO PORTLAND PITTSBURG
Manufacturers of

Monarch Patent Mine Car Hitchings

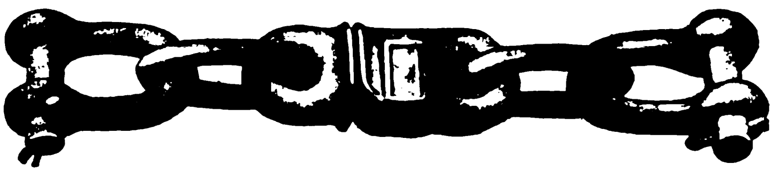
Also Makers of
Wire Rope of Every Description.

Products

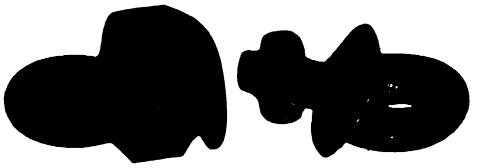
The MONARCH PATENT MINE CAR HITCHING, also wire rope, sockets, hooks, thimbles, blocks, manila rope, tramways, etc., described in other sections of the Mining Catalog.

The Monarch Mine Car Hitching is a safe, positive, coupling for mine cars which, on account of its ease of operation, simplicity of construction, strength, and sureness of action is being adopted by a number of the larger coal companies. Its use on mine cars does away with the serious and expensive accidents arising from the accidental uncoupling of cars or from the breakage due to mistakes and errors in figuring strengths where stresses are greatest.

As shown in the illustrations, Monarch Mine Car Hitchings are extremely simple; they have no screws, nuts, springs, or washers to loosen or become lost. There are no small parts to be broken when hanging loose while the cars are uncoupled. The parts of the coupling are stronger than the chain.



Style No. 1—For Vertical Draw Bar.



Coupling Open.

It is applicable to all classes of haulage—Electric, rope or mules, and both vertical and horizontal draw-bar. It is the product of practical experience and is the result of experiments conducted with the view of producing a device for all classes of mine haulage, all local mine conditions, adaptable to any draw-bar, car or load.

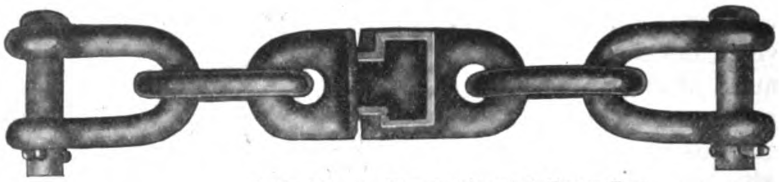
Construction

The male end of the coupling is made "T"-shaped with a short end protruding. The shoulders and neck are round. The female end is hollow with one side cut away for inserting the male end. At the back of the hollow is a hole for inserting the extended end of the male part. This forms an important part of the locking scheme.

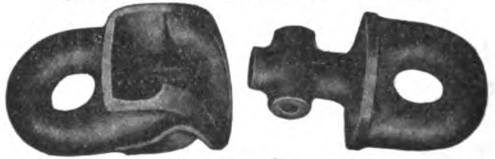
The materials used in the construction are the best obtainable. The castings are made of either malleable iron or of steel. The links are made of Sweedish iron and the clevices are drop forge mild steel.

Operation

Monarch Car Hitchings are wonderfully easy to couple and uncouple, saving much valuable time. To couple, the ends are held at an angle and the stub end and shoulders of the male end inserted in the side of the female part. When the coupling straightens out the stub enters the hole, and the shoulders push out against the end sections. The coupling is then made, and once made it can be uncoupled only when the operator willingly and knowingly opens them. To uncouple, the coupling is held up, bent at an angle and the male end withdrawn from the side. As shown in the illustration on the right, the coupling rides vertical. The locking scheme is not dependent upon gravity, hence it will not tend to be jarred open when the cars pass over high road-bed while the hitching hangs slack.



Style No. 2—For Horizontal Draw Bar.



Coupling Open.

It is permanently attached to the car, always ready for action. It will not interfere with the dumping of the car, and mud, clay, water, or weather will not affect its operation.

Specifications

Our regular stock specifications are as follows:

	Malleable Iron	Steel
Length	24 inches	28 Inches.
Links	⅞" Stock	1⅛" Stock.
Clevises	1⅛" Body	1¼" Body.
	1¼" Pin	1⅜" Pin.
	2" Spread	2" Spread.
Weight	25 Pounds	32 Pounds.
Strength	40.000 Pounds	55,000 Pounds.

References

The following is a list of users, of whom you are asked to inquire concerning the performance of the Monarch Hitching:

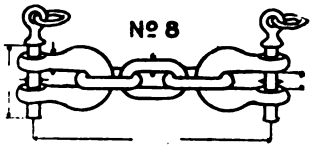
COMPANY	ADDRESS
J. K. Derring Coal Co.	Chicago
Johnston City Coal Co.	Chicago
Mt. Olive & Staunton Coal Co.	Staunton, Ills.
Miami Coal Company	Clinton, Ind.
Peabody Coal Co.	Chicago
Kerens-Donewald Coal Co.	St. Louis
Higgins Martin Coal Co.	Terre Haute, Ind.
Tecumseh Mining Co.	Bicknell, Ind.
Vandalia Coal Co.	Terre Haute, Ind.
Producers Coal Co.	Chicago
Old Ben Mining Corp.	Chicago
Searle Coal Co.	Johnson City, Ills.
W. B. Bogle & Co.	Terre Haute, Ind.
Carbon Block Coal Co.	Centerville, Iowa
Walton Coal Co.	Higbee, Mo.
Sesser Coal Co.	Chicago
Eagle Iron Works	Terre Haute, Ind.
Shamrock Coal Co.	Erie, Colo.

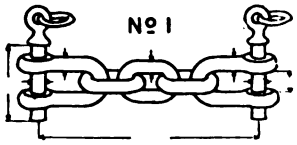
PITTSBURGH KNIFE AND FORGE CO.

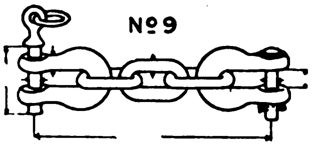
709 Belmont St. North Side
PITTSBURGH, PA.

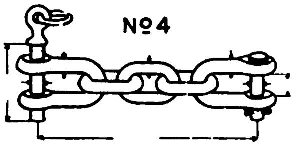
THE "HARRIS" MINE CAR HITCHINGS
(Our specialty since 1876)

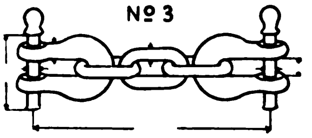
We recommend the Reinforced Clevis Hitchings as being vastly superior to the old style straight clevis hitchings, due to the extra strength and longer life. Made from BROWN & CO.'S SPECIAL DOUBLE REFINED IRON, STRICTLY HAND WELDED.

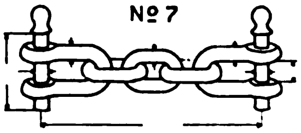


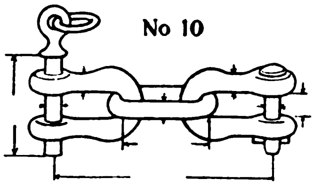


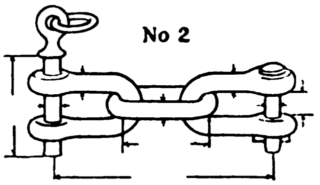


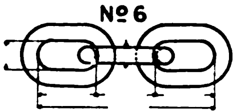


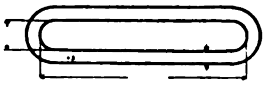




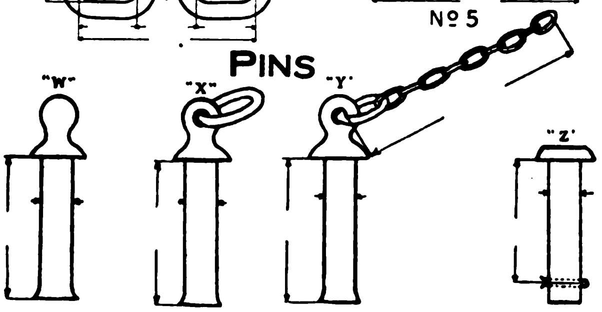








PINS



When sending us your order or writing for prices please give us the following information:

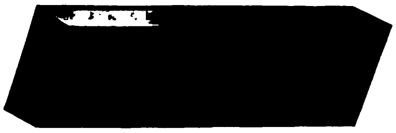
No. of hitchings wanted..............................
Style of hitching......................................
Size of Clevis..............Clevis Opening..............
Size of Pins..
Size of Links...
Center to center distance of pins......................

When pins "W," "X" or "Y" are ordered, unless otherwise specified, we will furnish same with swelled ends so they cannot come out of clevises.

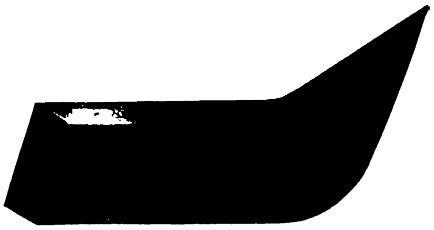
When no center to center dstance is given we will furnish hitchngs of our standard lengths.

"SUPERIOR" BIT STEEL. FINISHED BITS. PUNCHER PICKS

Our "SUPERIOR" BIT STEEL is used by 75% of the operators in the United States who use chain cutting machines, with the best of results.



We furnish FINISHED MINING MACHINE BITS, in all sizes and pattern of points, smoothly forged, with correct taper, made from our "SUPERIOR" Steel, which is rolled true to size and absolutely uniform at all times. We guarantee our Bits to cut more coal than any other make on the market.



The quality of this material, our prompt deliveries and equitable prices have enabled us to establish a trade on this product which will equal, in volume, more than double that of our competitors combined.

Puncher Picks

We have manufactured Puncher Picks ever since they were first used, and in our experience have tried out many grades of steel with the result that we have established two grades.

Our No. 1 Pick is made from "SUPERIOR" Steel the same as used in Finished Bits and the best of results are being obtained by our customers, who cover possibly 90% of the operators using the air punching machines.

Our No. 2 Pick is made from Crucible Tool Steel and is recommended for extreme cases where the coal is mined under exceptional difficulties. Made to fit all makes of air punching machines.

Write for our New Catalogue.

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

MINE LOCOMOTIVE SECTION

Engineering Data

Specification Data.
Table—Gross Tons Hauled by Electric Locomotives, average track conditions.
Sizes of Rail for various weights of Locomotives
Relation of Wheel Base to Radius of Minimum Curve.

The following manufacturers have catalogue descriptions in this section:

Alexander Car Replacer & Mfg. Co.
American Abrasive Metals Co., The.
Baldwin Locomotive Works.
Edison Storage Battery Co.
Electric Storage Battery Co.
Electric Service Supplies Co.
Fate, J. D. Co., The.
General Electric Co.
Goodman Mfg. Co.
Gould Storage Battery Co.
Hess-Bright Mfg. Co.
Indiana Foundry Co.
Ironton Engine Co.
Jeffrey Mfg. Co.
Lakewood Engineering Co., The.
Mancha Storage Battery Loco. Co.
Milwaukee Locomotive Mfg. Co.
Morgan-Gardner Electric Co.
Nuttall, R. D., Co.
Pennsylvania Casting & Mch. Works.
Philadelphia Storage Battery Co.
Porter, H. K., Co.
S. K. F. Ball Bearing Co.
Standard Roller Bearing Co.
Tool Steel Gear & Pinion Co.
Vissering, Harry & Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.
Whitcomb, Geo. D., Co.

For additional descriptions of Mine Locomotives and Equipment, not appearing in this section, refer to Index of Products in front of book.

Specification Data for Haulage Locomotives

Type Required

- Electric
- Compressed Air
- Gasoline
- Steam
- Storage Battery

Size or Weight Locomotive Required.

Number Required

Dimensions

- Maximum width locomotive can have
- Maximum height locomotive can have
- Is it necessary to take apart to install (in case of shaft mine?)

Track

- Weight of Rail ...... lbs. per yard.
- Exact gauge of track on straight haul
- Exact gauge of track on curves
- Radius of shortest curve in feet from center of track
- Length of shortest curve
- Average length of haul

†Grades

- Maximum grade in favor of load is...% for...ft.
- Maximum grade against load is ....% for ....ft.
- What is the average grade and is it in favor or against the load
- Length of maximum grade (in favor of load ....
- Length of maximum grade (against load ....
- If curves occur on grade, what is radius and grade

Haulage Conditions

- Width of entry
- Height of entry over rail and at lowest point in rooms
- Clearance each side of track
- Number Cars to be hauled per day
- Number Cars per trip
- Number of places to haul from

*Cars

- Length of Pit Car
- Width of Pit Car
- Weight of Pit Car empty
- Weight of Pit Car and load
- Diameter of Pit Car Wheel
- Length of Wheel Base
- Do Pit Cars have single or double bumpers
- Height from top of rail to top of bumper
- Height from top of rail to bottom of bumper
- Width from outside to outside of bumpers
- Height from top of rail to center of hitching
- Dimensions of coupling—length and width, inside and outside

Trolley Wire (Use this for electric locomotives).

- Location—Right or left side going toward face
- Distance of trolley wire outside of track rail
- Highest point in trolley wire above rail
- Lowest point in trolley wire above rail
- Location of motorman
- Voltage
- For gathering locomotive, give longest haul locomotive must make using cable

Gasoline Locomotives

- Is haul inside or outside
- Kind of liquid fuel available
- Altitude above sea level
- State ventilating conditions

Compressed Air Locomotives

- Elevation above sea level of compressor location
- Will compressor be operated by steam or water power
- If steam, state pressure
- If slope mine give length and pitch
- If shaft mine give depth
- Give distance from convenient location for compressor to head of shaft or slope
- If drift mine, state distance from convenient location for compressor to parting outside where locomotive will deliver loaded cars.

Storage Battery Locomotives

- What source of power, giving voltage, etc., will be used to charge locomotive batteries?
- Number of entries to be served for gathering locomotive
- Number working rooms to be served on each entry
- Give a schedule of the service required of the locomotive, stating when at work and when idle throughout the twenty-four hours?
- Will it be possible to give the battery a boosting charge at any time during the day?

*Note:—

If possible, it is expedient to furnish drawings of cars showing draught rigging so that locomotive may be arranged to suit.

†Note:—

A sketch or better, a map of your tracks with notations thereon in regard to grades and elevations at various points and referring to the weights of, or number of carloads of material which must be hauled between the various points per hour or in 5, 8 or 10 hours, and with a convenient location for the compressor indicated, usually gives a much clearer idea of your requirements than it is possible to give by tabulated method. A profile of important roads, or those where excessive or irregular grades occur may also suggest important alterations in the equipment. If haulage roads are to be lengthened, indicate which ones, and at what rate in feet per year they may be expected to increase in length. If the quantities to be hauled will increase, state how soon and how much. Also what lengths of haul and what quantities you wish to provide for in making the initial installation.

Gross Tons Hauled by Electric Locomotives

TABLE A. HAULAGE CAPACITY OF ELECTRIC MINE LOCOMOTIVES EQUIPPED WITH CAST CHILLED WHEELS

This table gives the drawbar pull in pounds and the haulage capacity in tons for a given weight of locomotive on various grades, when equipped with chilled cast-iron wheels. A co-efficient of friction of 30 lb. per ton has been assumed on level track, and 20 lb. per ton for each per cent. of grade.

Grade	Level		1%		2%		3%		4%		5%		6%		7%		8%		9%		10%	
Loco. Wght., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons
3	1200	40	1140	23	1080	15	1020	11	960	9	900	7	840	6	780	5	720	4	640	3	600	2
4	1600	53	1520	31	1440	20	1360	15	1280	12	1200	9	1120	7	1040	6	960	5	880	4	800	3
5	2000	67	1900	38	1800	26	1700	19	1600	15	1500	11	1400	9	1300	8	1200	6	1100	5	1000	4
6	2400	80	2280	45	2160	31	2040	23	1922	17	1800	14	1680	11	1560	9	1440	7	1320	6	1200	5
7	2800	93	2660	53	2520	36	2300	25	2240	20	2100	16	1960	13	1820	11	1680	9	1540	7	1400	6
8	3200	107	3040	61	2880	41	2720	30	2560	23	2400	18	2240	15	2080	12	1920	10	1760	8	1600	7
10	4000	133	3800	76	3600	51	3400	38	3200	29	3000	23	2800	19	2600	15	2400	13	2200	10	2000	9
12	4800	160	4560	91	4320	62	4080	45	3840	35	3600	28	3360	22	3120	18	2880	15	2640	13	2400	10
13	5200	174	4940	98	4680	67	4420	49	4160	38	3900	30	3640	24	3380	20	3120	16	2860	14	2600	11
15	6000	200	5700	114	5400	77	5100	57	4800	43	4500	35	4200	28	3900	23	3600	19	3300	16	3000	13
17	6800	226	6460	129	6120	87	5780	64	5440	49	5100	39	4760	32	4420	26	4080	21	3740	18	3400	15
18	7200	240	6840	136	6480	92	6120	68	5760	52	5400	41	5040	34	4680	28	4320	23	3960	19	3600	16
20	8000	267	7600	152	7200	103	6800	75	6400	58	6000	46	5600	37	5200	31	4800	27	4400	21	4000	17
25	10000	330	9500	190	9000	118	8500	95	8000	72	7500	58	7000	46	6500	38	6000	32	5500	26	5000	22
30	12000	400	11400	227	10800	156	10200	113	9600	87	9000	70	8400	56	7800	46	7200	38	6600	32	6000	26

TABLE B. HAULAGE CAPACITY OF ELECTRIC MINE LOCOMOTIVES EQUIPPED WITH STEEL-TIRED WHEELS

This table gives the drawbar pull in pounds and the haulage capacity in tons for a given weight of locomotive on various grades, when equipped with steel-tired wheels. A co-efficient of friction of 30 lb. per ton has been assumed on level track, and 20 lb. per ton for each per cent. of grade.

Grade	Level		1%		2%		3%		4%		5%		6%		7%		8%		9%		10%	
Loco. Wght., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons	Draw-bar Pull, lb.	Haul-age Cap., tons
3	1500	50	1440	29	1360	20	1320	15	1260	12	1200	9	1140	8	1080	6	1020	5	960	4	900	4
4	2000	70	1920	39	1840	26	1760	20	1680	15	1600	12	1520	10	1440	8	1360	7	1280	6	1200	5
5	2500	84	2400	48	2300	33	2200	24	2100	19	2000	15	1900	13	1800	10	1700	9	1600	8	1500	6
6	3000	100	2880	58	2760	39	2640	29	2520	23	2400	18	2280	15	2160	13	2040	11	1920	9	1800	8
7	3500	117	3360	67	3220	46	3080	34	2940	27	2800	22	2660	18	2520	15	2380	12	2240	11	2100	9
8	4000	133	3840	77	3680	53	3520	39	3360	30	3200	25	3040	20	2880	17	2720	14	2560	12	2400	10
10	5000	167	4800	96	4600	66	4400	49	4200	38	4000	31	3800	26	3600	21	3400	18	3200	15	3000	13
12	6000	200	5760	115	5520	79	5280	59	5040	46	4800	38	4560	30	4320	25	4080	21	3840	18	3600	16
13	6500	216	6240	126	5980	85	5720	63	5460	50	5200	40	4940	33	4680	27	4420	23	4160	20	3900	17
15	7500	250	7200	144	6900	99	6600	73	6300	57	6000	46	5700	38	5400	32	5100	27	4800	23	4500	19
17	8500	283	8160	163	7820	112	7480	83	7140	65	6800	52	6460	43	6120	36	5780	30	5420	26	5100	22
18	9000	300	8640	173	8280	118	7920	88	7560	68	7200	55	6840	45	6500	38	6120	32	5760	27	5400	23
20	10000	333	9600	192	9200	132	8800	98	8400	76	8000	62	7600	51	7200	42	6800	36	6400	30	6000	26
25	12500	416	12000	240	11500	164	11000	122	10500	96	10000	77	9500	64	9000	53	8500	45	8000	38	7500	32
30	15000	500	14400	287	13800	197	13200	146	12600	114	12000	92	11400	76	10800	63	10200	53	9600	46	9000	39

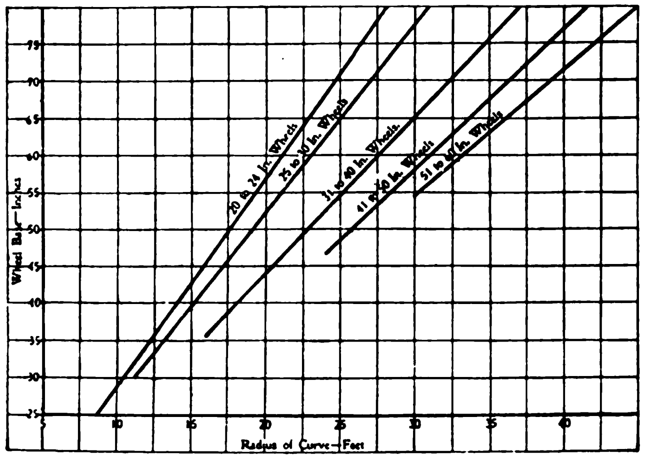
Courtesy Jeffrey Manufacturing Co.

Minimum Sizes of Rails

Minimum sizes of rail recommended for mine locomotives are given in the following table. The values are approximate only, as the proper weight, or size, of rail that should be used is determined by the character of the road bed, the spacing of ties, and general construction. For average conditions in general mine and industrial service, rails of the following minimum sizes are recommended:

Weight of Locomotive in Tons	Weight of Rails in Pounds Per Yard
4 to 6	16
6 to 8	20
8 to 10	25
10 to 13	30
13 to 15	40
15 to 20	50

RELATION OF WHEEL BASE TO RADIUS OF MINIMUM CURVE



The graphical statement of this relation given by the curves is plotted from values obtained from a formula given in the Baldwin Locomotive Works' "Locomotive Data." Experience has shown the values to be safe ones for standard wheel, flange, and truck play. To insure that the curves will give safe results, the same gauge is assumed on curves as on tangent track. If a liberal "spread" is provided in the track at curves, the values of the curves for wheel base may be increased by from 10 to 25 per cent.

Courtesy Westinghouse Electric & M'f'g Co.

GOODMAN MANUFACTURING CO.

ELECTRIC MINING MACHINERY

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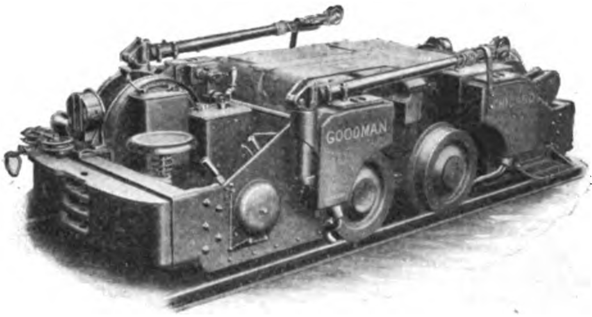
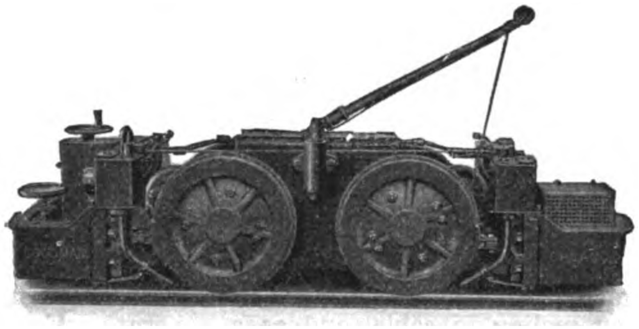
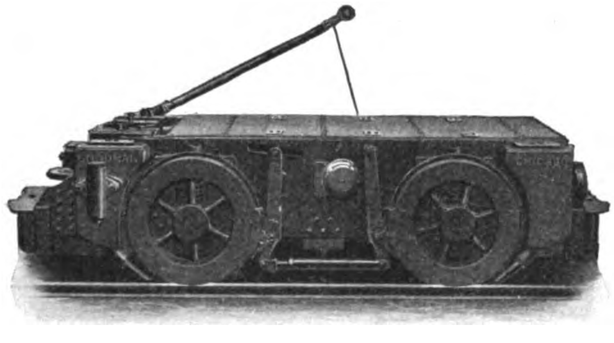
The Articulated Storage Battery Locomotive.



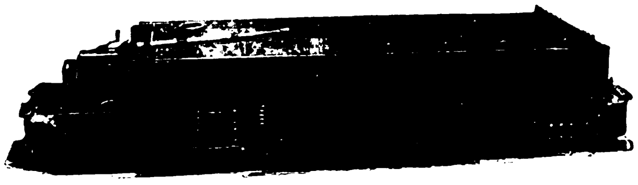
Low Vein "Universal" Gatherer, with Electric Cable Reel and Crab Reel.



7-Ton Single-Motor Haulage Locomotive. Unit Drive for All Four Wheels.



8-Ton Two-Motor Haulage Locomotive. Plate Steel Frame and Outside Wheels.



20-Ton Three-Motor Haulage Locomotive. Cast Steel Frame and Inside Wheels.

The Goodman Line of Electric Locomotives provides a type and size for every service.

Gathering Locomotives:	**Haulage Locomotives:**
Trolley and Reels	**Traction Types**
Storage Battery	**Rack Rail System**

Meeting all mining conditions by exactly suitable equipment, rather than by "adaptations" of nearly-right standards.

Storage Battery Gatherers

The Articulated Locomotive, with battery carried low, between two bogy trucks, each having two wheels driven and two idle. All parts accessible; ample battery capacity. Easy operation around sharp curves, through narrow entries and under low roof. Fitted with trolley pole for combination service. Made also in four-wheel type, for light service. Bulletin No. 521.

Trolley Gatherers

In numerous types and sizes, for car distribution and gathering by all methods of operation. (a) Plain locomotives for entry gathering and simple switching. (b) Electric cable reel locomotives for working to the face in rooms and entries. (c) Crab reel locomotives for working on the trolley-wired entries and reaching with wire rope to get cars from the face in dip rooms. Combination electric cable and crab reel locomotives as truly "Universal" gatherers. Bulletin No. 593.

Traction Haulage Locomotives

In single-motor, two-motor and three-motor types, for lightest to heaviest service. Bulletin No. 461.

Single-Motor Locomotives, for light and medium service, in weights 3 to 10 tons. The one armature, geared to both axles, gives a positive unit drive for all four wheels and assures maximum pulling power per ton of weight. The design is characterized by simplicity of construction, with ample proportions for all parts. Wholly accessible from above—no underneath work to do. Bulletin No. 402.

Two-Motor Locomotives in various forms of frame construction, motor arrangement, etc., to suit operative conditions and purchasers' preferences. Bulletin No. 451.

Three-Motor Locomotives for heavy duty service, distributing the weight over six wheels instead of four, thereby reducing unit wheel pressures and avoiding necessity for use of excessively heavy rail sections. Bulletin No. 461.

Rack Rail Locomotives

For positive haulage in hilly mines where grades make traction operation difficult, unsafe or uneconomical. The limitations of adhesion as a tractive basis are avoided and full value is given to the motor horsepower. Bulletin No. 301.

GENERAL ELECTRIC COMPANY

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Schenectady, N. Y

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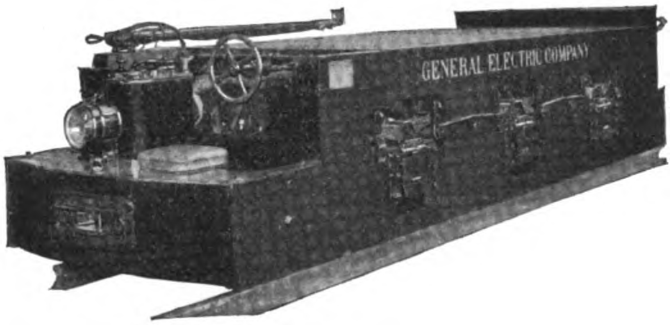
In All Large Cities

Electrical Equipment for Mines---Locomotives

Many types of mining locomotives are manufactured by the General Electric Company. For any given set of haulage conditious just the right type of locomotive can be selected. The wide choice possible makes compromises unnecessary. Two representative types of these locomotives are illustrated to show the wide variety available.

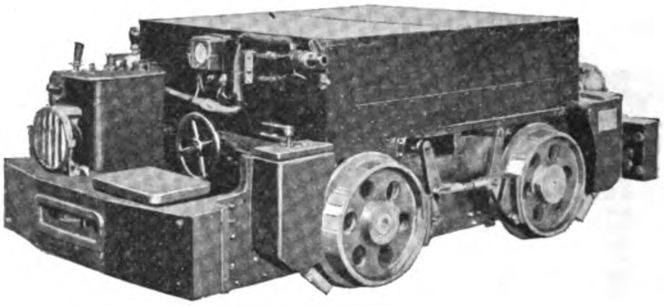


20 Ton G-E Mining Locomotive, Rochester and Pittsburgh Coal and Iron Co., Punxsutawney, Pa.

The locomotive shown at the bottom of this column weighs six tons, is 42″ track gauge and will develop a maximum draw bar pull of 3500 pounds. When desired it can be built for a minimum track gauge of 30″. It will operate from either a 250-volt trolley or its self-contained storage battery. The change from trolley to storage battery operation is made entirely automatic, by a switch which makes the necessary connections without attention from the operator. This locomotive's storage battery is automatically charged when locomotive is running from trolley wire.

Straight storage battery locomotives without trolley operating feature are furnished when desired. These locomotives are more than meeting the high expectations of users generally.

The locomotive shown above was built for underground haulage at Rochester and Pittsburg Coal and Iron Company. It is equipped with three 85 H. P. motors, each provided with ball bearings which prevent armature from touching pole pieces, keep oil out of motor, maintain commutator in alignment, cut down bearing friction and reduce quantity of lubricant required. Sparkless commutation is assured by the use of a special motor construction. Although this locomotive has a long wheel base, it is easy on track. It weighs twenty tons and will develop a maximum draw bar pull of twelve thousand pounds. Great strength is assured by massive rolled steel side frames.

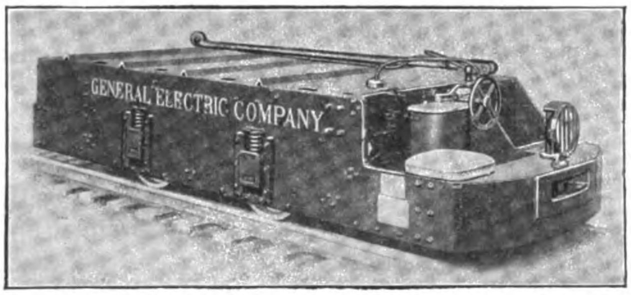


5 Ton Storage Battery Locomotive.

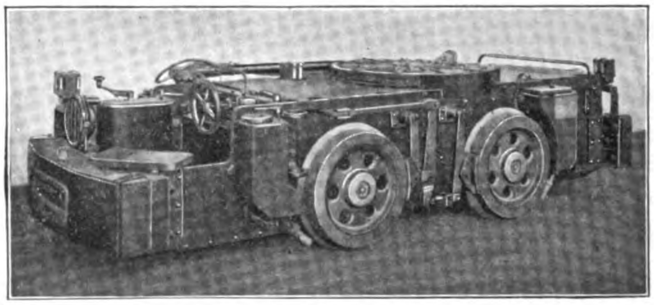
The locomotive below can be operated between working face and entry without a trolley wire. Simply hook the cable to entry trolley; throw in motor switch and operate locomotive forward or backward without fear of over-runing or kinking cable.

Constant tension on cable is obtained by a ball-bearing motor geared to a ball-bearing reel. The motor is always connected across the power line, acting as an endless spring. It runs as a motor when reeling in cable, and as a generator when paying out cable. It maintains a firm pull, and will not burn out when locomotive is standing still. The motor is under the reel and completely protected from falling top. Mechanical springs catch and break, chain drives are complicated and expensive to maintain,—friction drives are non-positive and wear rapidly—the "electric spring" has none of these disadvantages.

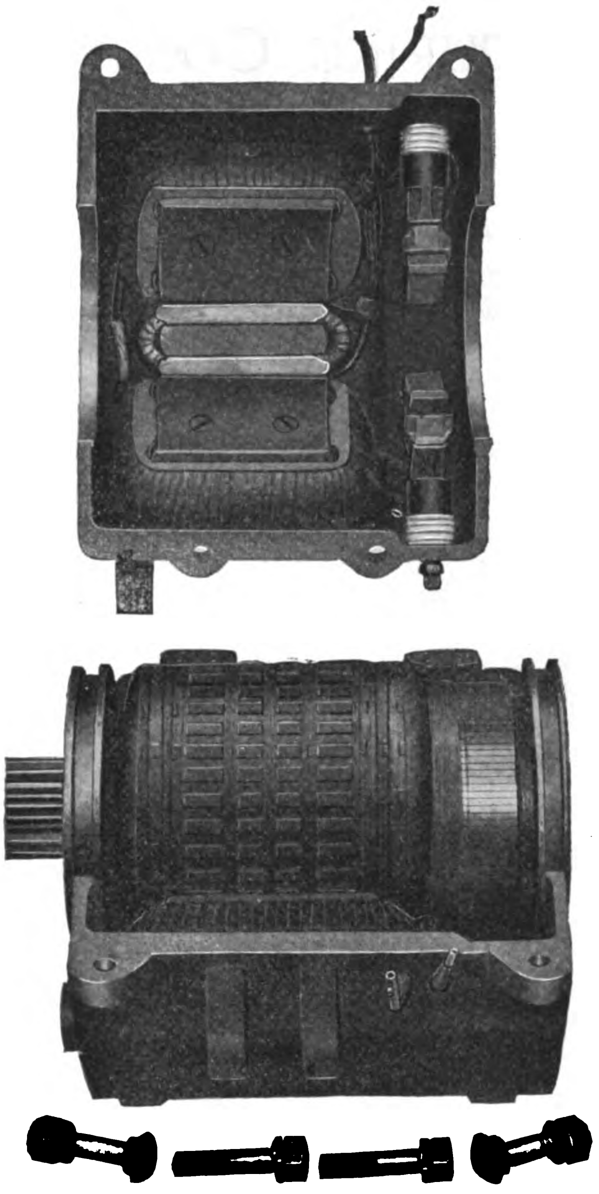
Bulletin No. 4790A, "Mining Locomotives," will be sent on request.



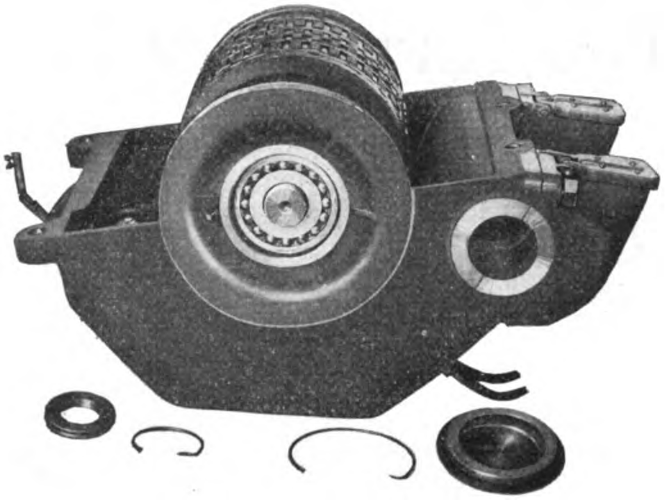
Combination Storgae Battery and 250 Volt Trolley Locomotive.



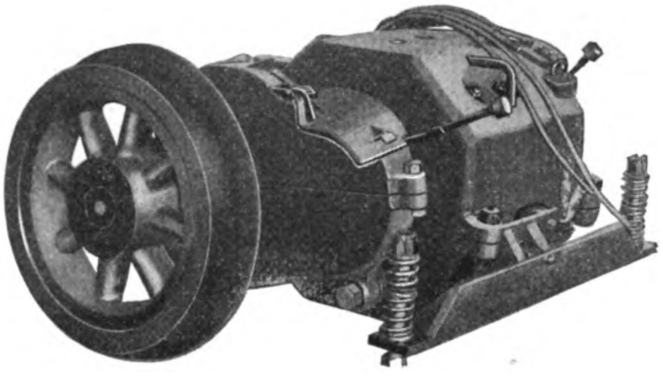
Gathering Locomotive with Cable Reel.



G-E Mining Locomotive Motor and Cover.



Motor, Showing Ball Bearing.



Motor on Axle (Suspension Side).

Mine Locomotives

The service under which mine locomotives operate is apt to vary considerably, therefore the motors must be designed for overloads and severe service.

The capacity of the various motor equipments with which the G-E standard locomotives are equipped is such that they will not only operate satisfactorily but will slip the wheels under all conditions.

The size of these equipments is the result of long experience with many mine locomotives operating under various conditions.

All HM motors in the standard line used with G-E locomotives are all of the split frame type with armature carried in separate bearing heads.

The suspension lugs are on the lower half of the frame, so that the upper half may be removed and the armature taken out without disturbing the suspension bar.

The suspension bars are spring supported from the locomotive frame.

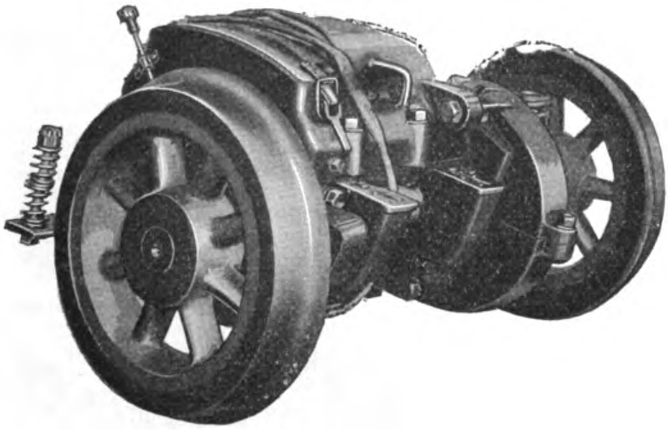
The armature punchings are assembled on a cast iron spider. The Commutator is assembled on a separate spider, which is pressed on a hub extension of the main spider.

This construction permits the removal of the armature shaft without having to disturb the armature windings or commutator. The construction of armature and field coils embodies the best engineering knowledge of operating conditions and the use of the very best materials obtainable for the class of service to be met.

It must be appreciated that the satisfactory service of the locomotive can only be guaranteed when complete service data is known.

It is therefore desirable to have the following information.

1st—Profile of the road.
2nd—Radius and locaton of curves.
3rd—Weight of empty car.
4th—Weight of loaded car.
5th—Number of cars per trip.
6th—Number of trips per day for a certain number of hours.
7th—Number of stops, if any, per trip and also in what part of the road they occur.
8th—Weight of rails and some indication as to track conditions.



Motor on Axle.

THE JEFFREY MANUFACTURING COMPANY

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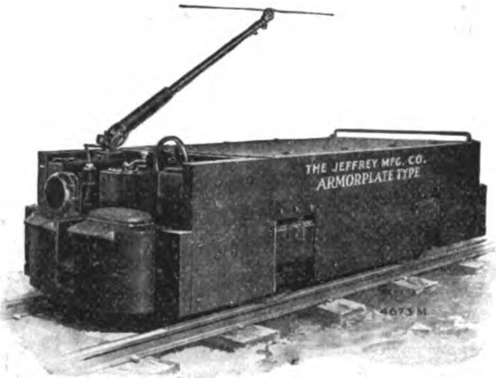
The Jeffrey "Armorplate" Type Mine Haulage Locomotive

Built in sizes from 7 tons to 30 tons in weight.



All Parts Are—

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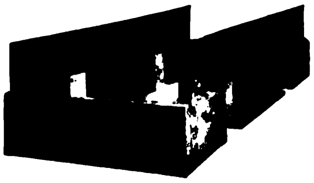
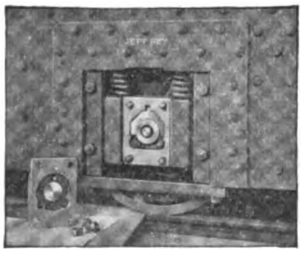
Some Distinctive Features In design and Construction Which Guarantee Maximum Service at Minimum Cost:



Armorplate Type Locomotive Frame

Not made of a casting, but of a forging—it needs no guarantee against breakage. This type of frame permits for a given weight of locomotive the largest possible motor capacity for a given gauge, as well as greater accessibility to parts.

Cost of upkeep is reduced to the minimum.



New Style Journal Box for Inside Wheel Type Locomotives

Hardened Steel Plate in the journal box lid takes the end thrust of a Hardened Steel Pin in the end of the axle—eliminates wear between the wheel hubs and journal boxes.

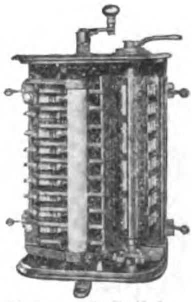
Heavy Capacity Ball Bearing Motors

Eliminate 90% of the ordinary mechanical troubles experienced by the use of Bushed Bearings.

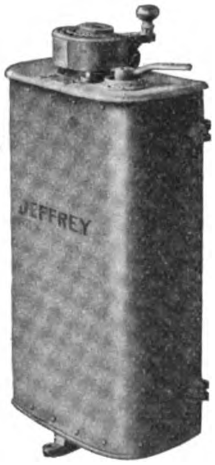
The Ball Bearings do away with pole shoe wear on the armatures, insuring maximum continuous service.

Motors cannot be overheated regardless of the weight of trip or the percentage of adverse grades.

The Jeffrey Improved Locomotive Controller



Note the long Solenoid Coil located above the controller fingers. The arc at the fingers is blown out from the fingers. Arc deflectors are arranged in the form of shelves and are separate, making repairs easy and cheap.

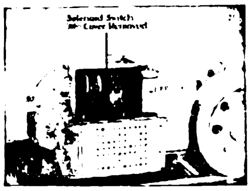


The Jeffrey Arcmaster and Solenoid Switch

Standard on all Jeffrey Locomotives above Four Tons Weight.

The "Arcmaster" is mounted on the top of the controller and serves as a handle and works in conjunction with the standard controller cylinder. It controls the operating switch of a rugged contactor Solenoid Switch which can be mounted anywhere on the locomotive where it will be protected from mechanical injury. Reduces cost of upkeep and increases safety of locomotive operation.

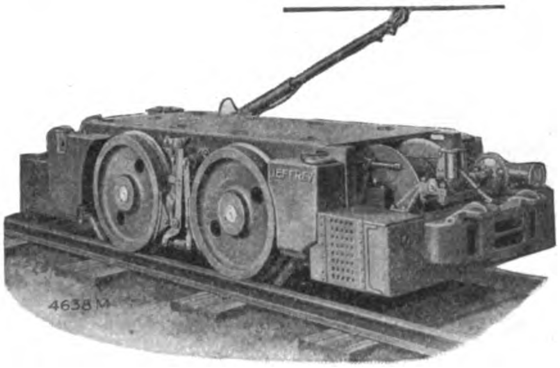
Write for Arcmaster Bulletin No. 204.



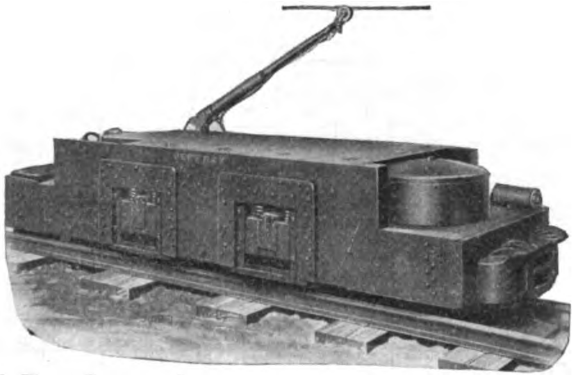
The Contactor has large renewable contact plates, giving it long life.

THE JEFFREY MANUFACTURING COMPANY

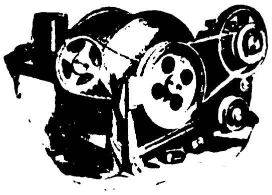
Electric Gathering Locomotives



Cable Reel Type Locomotive
for gathering loaded cars under practically all mining conditions. Low overall height. Various types of reels.



Crab Type Locomotive
Particularly useful where rooms run to the dip, or where the cars are light and the room track level.

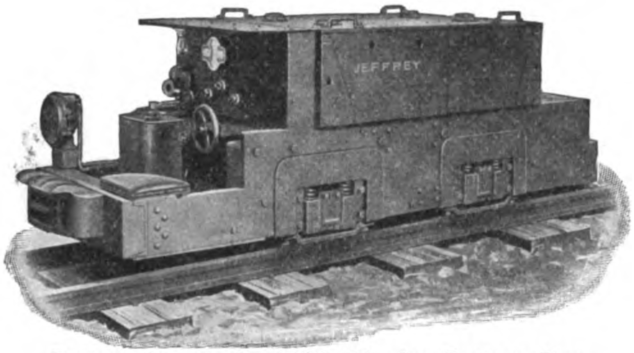


Standard Cable Reel Device
either motor or mechanically driven.

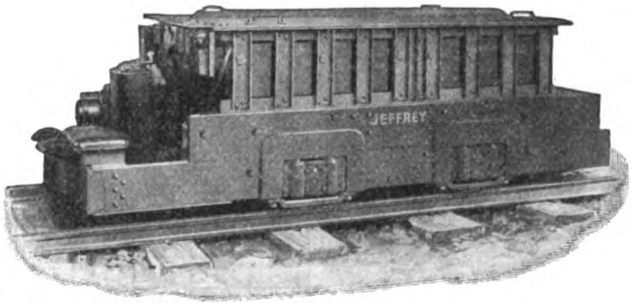
Standard Crab Reel Device. Rope.
Combination Crab and Cable Reels also furnished.

STORAGE BATTERY GATHERING LOCOMOTIVES.

Equipped with either Edison or Ironclad Exide Cells.

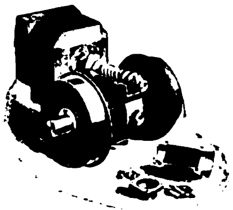


Battery Locomotive With Wooden Battery Box.

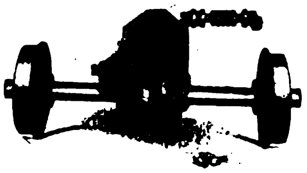


Battery Locomotive With Structural Steel Battery Box.

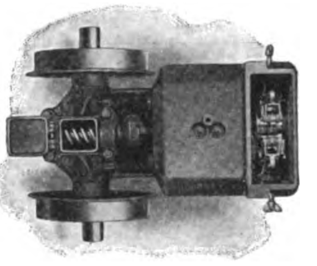
Practical, Economical and Reliable for gathering purposes where the average grade is not excessive. Operation is not restricted by the length of cable. Economical in upkeep because it does away with the cost of trolley wire, feeding, rail bonding and flexible cables, and the consequent repair costs. The most flexible form of mechanical haulage yet devised.



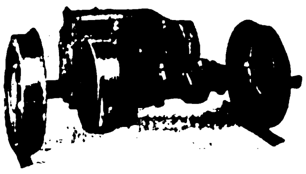
Motor Type M. H. 108.
Used on Battery Locomotives. Designed for minimum gauge of 18".



The Worm Drive
on Jeffrey Battery Locomotives has a mechanical efficiency of 95%.



Note the large commutator door with accessible brushes and holders, and large commutator.



Motor Type M. H. 124.

MORGAN-GARDNER ELECTRIC CO.

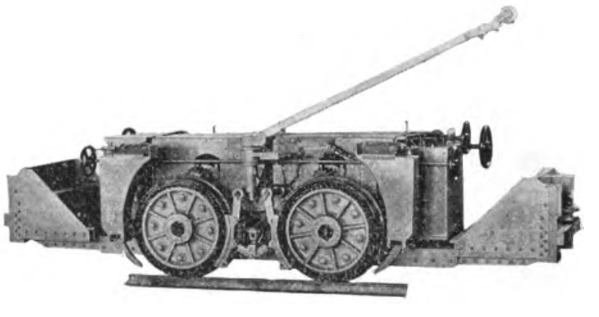
68 East Adams St., Chicago, Ill.

MINING LOCOMOTIVES

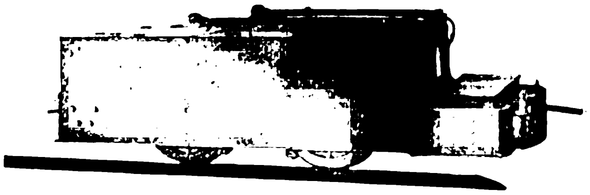
MINING LOCOMOTIVES

CLASS OF LOCOMOTIVE	R	F	M	N	RS	B	C	CC
HAULAGE TYPE	■	■	■	■	■	■	■	■
GATHERING TYPE	■					■	■	■
STEEL ROPE CRAB INDP MOTOR	■					■	■	■
ELECTRIC CABLE REEL	■					■	■	
SINGLE OR DOUBLE MOTOR	DOUBLE	DOUBLE	DOUBLE	DOUBLE	DOUBLE	SINGLE	SINGLE	DOUBLE
BRAKE HORSE POWER TOTAL HORSE POWER PER LOCO	60 BHP	80 BHP	100 BHP	150 BHP	60 BHP	40 BHP	60 BHP	100 BHP
VOLTAGE - D. C. CURRENT	250 500	250 500	250 500	250 500	250 500	250 500	250 500	250 500
GAUGE	32" UP	34" UP	34" UP	36" UP	24" TO 32"	18" UP	36" UP	34" UP
WEIGHT IN TONS	5 & 6	8	10	13 & 15	6	2½ & 4	5 & 6	10
DRAW BAR PULL - CLEAN RAIL	2500# 3000#	4000#	5000#	6500# 7500#	3000#	1250# 2000#	3330# 4000#	6000#
GEAR RATIO - FAST	1:4.8	1:4.8	1:5.2	1:4.8	1:4.8		1:6.9	1:5.4
GEAR RATIO - SLOW	1:5.5	1:5.5	1:6	1:5.5	1:5.5	1.8.3	1.8	
SINGLE OR DOUBLE GEAR REDUCTION	SINGLE	SINGLE	SINGLE	SINGLE	SINGLE	DOUBLE	DOUBLE	DOUBLE
ARMATURE PINION FACE	5"	5"	4¼" & 5½	6"	4"	3"	2.18"	3.5"
AVERAGE MILES PER HOUR	8 TO 10	8 TO 10	8 TO 10	7 TO 9	8 TO 10	4 TO 5	5 TO 7	6 TO 8
CONSEQUENT POLE MOTOR	■	■	■	■	■	■		
BALL BEARING - FOUR POLE - INTERPOLE MOTOR							■	■
SEMI-ENCLOSED MOTOR	■	■	■	■	■			
ENCLOSED MOTOR						■	■	■
SPRING DRAW BAR	■	■	■	■	■	SLOT & ROLLER	■	■
SPRING BUMPER							■	■
SPRING MAIN FRAME SUPPORT	■	■	■	■	■	■	■	■
SPRING MOTOR SUPPORT						■	■	■
SINGLE OR DOUBLE END CONTROL	DOUBLE	DOUBLE	DOUBLE	DOUBLE	DOUBLE	SINGLE	SINGLE	SINGLE
RHEOSTATIC AND SERIES & PARALLEL CONTROL	S & P	S & P	S & P	S & P	S & P	R	R	S & P
GRID RESISTANCE	■	■	■	■	■	■	■	■
PARALLEL GROUPING OF RESISTANCE	■	■	■	■	■	■	■	■
HEIGHT - RODS ON TOP	43⅛"	44⅜"	44⅜"	49⅞"	43⅛"			
HEIGHT - RODS ON SIDE OR BELOW COVER	36⅛"	37⅜"	42⅜"	42⅞"	36⅛"	32"	30" 32"	35"
WHEELS INSIDE OR OUTSIDE	OUTSIDE	OUTSIDE	OUTSIDE	OUTSIDE	OUTSIDE	INSIDE OR OUTSIDE	INSIDE	INSIDE
OVER TROLLEY ETC WIDTH - ADD TO GAUGE	8½"	8½	9"	9"	7"	11½"	17"	13¼"
WHEEL BASE	39½"	42"	48"	43"	39½"	36¾"	35⅞"	41
LENGTH WITH BUMPERS	155¼"	163¼"	172"	181"	155¼"	135"	127½"	137"
LENGTH WITHOUT BUMPERS	141¼"	149¼"	158"	167"	141¼"	121¼"	113½"	123"
STEEL TIRES DIAMETER OF WHEELS	26"	28"	30"	31"	26"	18"	22"	26"
HAND WHEEL OR LEVER BRAKE	WHEEL	WHEEL	WHEEL	WHEEL	WHEEL	LEVER	LEVER	LEVER
INCANDESCENT HEAD LIGHT	■	■	■	■	■	■	■	■
ONE TROLLEY POLE	■	■	■	■	■	■	■	■
TROLLEY POLE HOOK							■	■
TROLLEY PLUG SWITCH	■					■	■	■
EXTRA EQUIPMENT WHEN SPECIFIED	■	■	■	■	■	■	■	■
ARC LIGHTS, EXTRA TROLLEY POLE, ETC.—								

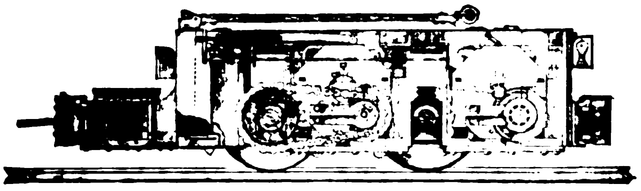
■ INDICATES, DESCRIPTION AT LEFT APPLIES TO HEADINGS



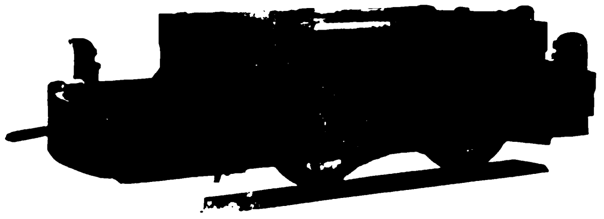
Type R, Haulage Locomotive.



Type CC, Haulage Locomotive.



Section of CC Locomotive.



Type C, Haulage Locomotive.

Type C, Gathering Locomotive.

The Morgan-Gardner Mining Locomotives have made an enviable record over a long term of years. All modern features are incorporated in the later designs. These locomotives have many exclusive features that increase their effectiveness. The rugged construction and careful workmanship insure reliability—always ready for service, and mean high economy of operation.

We build locomotives for all conditions of haulage, main line, gathering, or in low narrow workings.

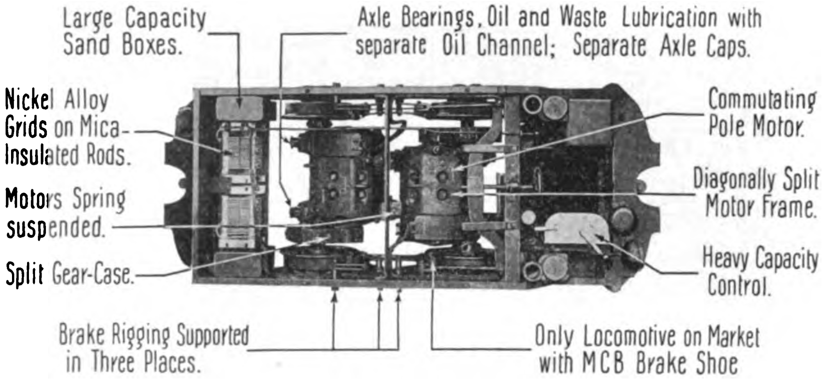
Let us assist with your haulage problem.

WESTINGHOUSE ELECTRIC & M'F'G CO.

EAST PITTSBURGH, PA.

THE BALDWIN LOCOMOTIVE WORKS

PHILADELPHIA, PA.


Large Capacity Sand Boxes.
Axle Bearings, Oil and Waste Lubrication with separate Oil Channel; Separate Axle Caps.
Nickel Alloy Grids on Mica-Insulated Rods.
Commutating Pole Motor.
Motors Spring suspended.
Diagonally Split Motor Frame.
Split Gear-Case.
Heavy Capacity Control.
Brake Rigging Supported in Three Places.
Only Locomotive on Market with MCB Brake Shoe

Trolley Locomotives.

Baldwin-Westinghouse Electric BARSTEEL Locomotives can be supplied in any commercial size, type, and for any class of service.

BARSTEEL frames consist of a grid work of steel bars, each side frame being cased in one piece. This construction being very flexible in design, permits the weight to be most efficiently distributed to withstand the heavy strain and violent shocks encountered in mining service.

The open frame also permits a high degree of accessibility for oiling, cleaning and inspecting, the slack in the brake rigging can be taken up and brake shoes easily replaced.

Wheels may be of cast iron with chilled threads, forged and rolled steel, or cast iron centers with steel tires.

Journal Boxes are of cast iron.

Headlights—the standard equipment includes two incandescent lights.

Brakes meet the most exacting requirements of safety and ease of manipulation.

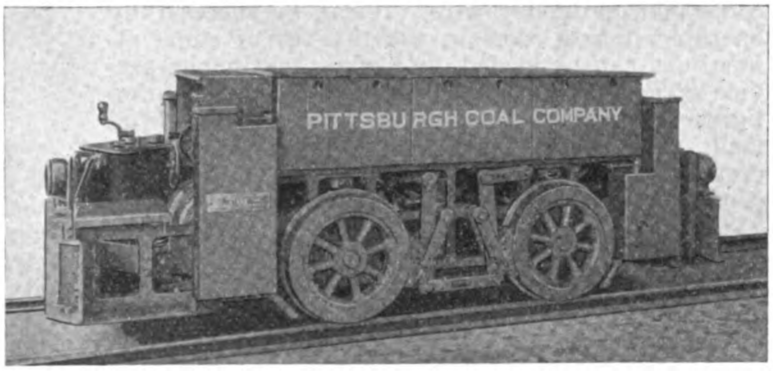
Sanding Devices—all standard locomotives are provided with large sand boxes at each end of both side frames.

Motor frames are of cast steel and are divided at a slight angle from the horizontal, which permits the suspension of the motor from the lower parts of the frame.

The commutating pole motors used on BARSTEEL Locomotives practically eliminate sparking and flashing; brush wear is very slight, and the commutator readily acquires and retains the desirable reddish!-brown polish.

Controllers are of the magnetic blowout type. A special feature of this controller is an arrangement that prevents the motorman from "bucking" the motors to stop the locomotive. All parts are massive and thoroughly ventilated, insuring long life and minimum repairs.

The same construction is used on storage battery locomotives.



Storage Battery Locomotive—Pittsburgh Coal Co.

Net Weight—Tons	WHEELS CHILLED IRON		WHEELS STEEL TIRED	
	†Rated D.B.P. in Lbs. Level Track	†Max. Tractive Effort in Lbs.	†Rated D.B.P. in Lbs. Level Track	†Max. Tractive Effort in Lbs.
Two-Motor Locomotives.				
3½	1400	1750	1750	2100
4	1600	2000	2000	2400
4	1600	2000	2000	2400
5	2000	2500	2500	3000
5	2000	2500	2500	3000
6	2400	3000	3000	3600
6	2400	3000	3000	3600
7	2800	3500	3500	4200
7	2800	3500	3500	4200
8	3200	4000	4000	4800
8	3200	4000	4000	4800
10	4000	5000	5000	6000
10	4000	5000	5000	6000
13	5200	6500	6500	7800
13*	5200	6500	6500	7800
15*	6000	7500	7500	9000
15	6000	7500	7500	9000
20	8000	10000	10000	12000
20	8000	10000	10000	12000
25	10000	12500	12500	15000

Net Weight—Tons	WHEELS CHILLED IRON		WHEELS STEEL TIRED	
	†Rated D.B.P. in Lbs. Level Track	†Max. Tractive Effort in Lbs.	†Rated D.B.P. in Lbs. Level Track	†Max. Tractive Effort in Lbs.
Three-Motor Locomotives.				
15	6000	7500	7500	9000
15‡	6000	7500	7500	9000
20‡	8000	10000	10000	12000
20	8000	10000	10000	12000
25	10000	12500	12500	15000
25	10000	12500	12500	15000
30	12000	15000	15000	18000
30§	12000	15000	15000	18000
35§	14000	17500	17500	21000

Storage Battery Locomotives for all requirements. Following are three common standards:

Chassis Weight.	D. B. P.	M. P. H.	Max. Kw. Hours.
6000	1200	3.5	20.8 to 23.8
7000	1600	3.5	26.6 to 29.7
8000	2000	3.5	35.5

Everywhere coal is mined you will find the BARSTEEL delivering the goods.

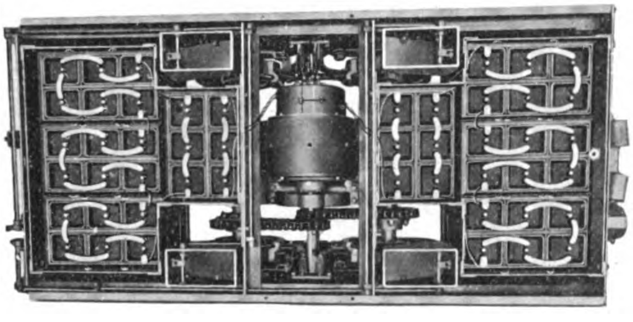
THE IRONTON ENGINE COMPANY

Factory and Office
IRONTON, OHIO
Manufacturers of

Storage Battery Locomotives

Products

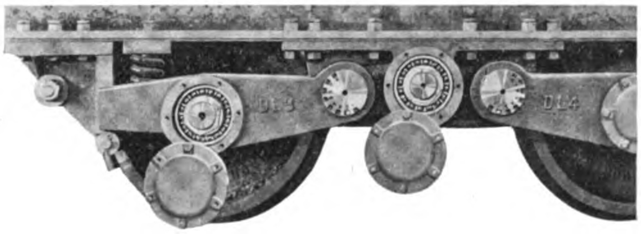
STORAGE BATTERY LOCOMOTIVES.



Top View of Locomotive, Showing Arrangement of Battery Compartments, Simplicity of Construction, Equal Distribution of Weight and Accessibility of Motor and Other Parts of the "Ironton." All Covers Removed.

Operation of the "Ironton" Locomotive

The "Ironton," having a self-contained power plant, with a supply of current ample for the maximum days work, requires no bonded rails, cables, cable man or trolley wire. It can be successfully operated in any room in which a car of equal dimentions can be loaded, and gives continuous service at a speed of 8 to 10 miles an hour running light, and from 4 to 5 miles an hour under full load. The capacity for uninterrupted service increases the tonnage hauled by from 25 to 50 per cent over other types of gathering locomotives.



The "Ironton" Radial Housing for Axle Bearing.

The care of the "Ironton" including the charging of the storage batteries, can be safely entrusted to the average mule driver, employed in mining, the only requirement being that he have intelligence enough to follow instructions. At the end of the day's work the "Ironton" is run to the station and connected to the charging panel. The inserting of two plugs, of unequal size, making a wrong connection impossible, and the closing of a knife switch are all the attention required. When batteries are fully charged the ampere hour meter and trip circuit breaker automatically open the line and prevent overcharging.

Flexibility

The flexibility of the "Ironton" is due to the low height, the simplicity of operation, and the construction. The "Ironton" is only 32 inches high and hence can be driven up and coupled to loads at the face, making the use of cables, cable reels, crab reels, etc., unnecessary. The prime mover is a single powerful motor placed in the center of the locomotive. The single large motor has several advantages over the twin motors used in other types. The number of working parts is reduced, and correspondingly, the number of bearings and the power required to overcome friction. Being a unit, its action is quicker and more positive; it starts the trips more quickly and pulls harder, and is easier to control in difficult places.

The "Ironton" in Leckie Collieries Company's Mines, Aflex, Ky. Working in 35-Inch Coal.

The construction and length of the wheel base add much to the flexibility of the "Ironton." With wheel base of only 36 inches, the weight of the locomotive is concentrated on a very small area of track surface. This greatly reduces the possibility of one or more of the drivers being relieved of pressure because of vertical deflections of the rails, and decreases the liability of derailment on curves. The construction of the wheel base makes it easy to handle over bad tracks, as all tilting and swaying is overcome by the radial housing shown in the illustration.

Construction

Power is transmitted to a jack shaft from the motor by a gear and pinion and from the jack shaft to both axles by roller chains and sprockets. In the whole machine there are but 8 bearings, and each of these is a self-aligning ball- or roller-bearing. A simple adjustment is provided for taking up the slack in the driving chains, and the adjustment can be made without removing any part of the locomotive.

The frame is heavy channel steel, reinforced at corners with a heavy steel angle, and cross braced at the top by angles and at the bottom by steel rods. The brakes are of the equalizing automatic locking screw type, acting on all wheels. The brake shoes can be easily replaced and repaired; the brake in controlled by a large hand wheel conveniently placed for the operator. The sand boxes are cast iron, are placed directly above each wheel with a straight pipe leading to the track, and are rain and drip proof.

THE LAKEWOOD ENGINEERING CO.

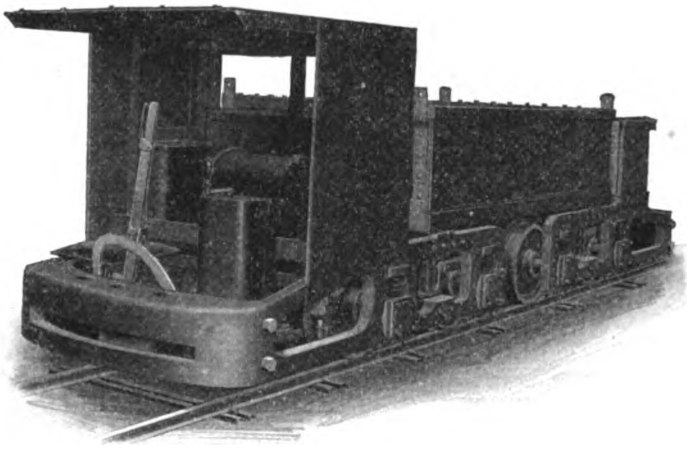
CLEVELAND, OHIO. U. S. A.

LAKEWOOD
BUILT TO LAST

Storage-Battery, Trolley, and Gasoline Locomotives

Products

Storage-battery, trolley and gasoline locomotives for gathering and main haulage work; industrial cars and track; clam shell buckets for coal loading.



Battery Locomotives

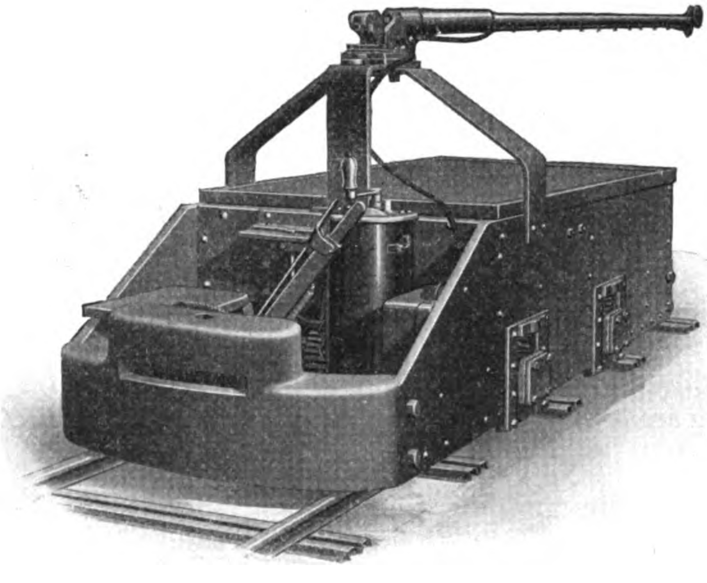
Three to 5 ton machines of the four wheel type for gathering; 6 to 10 ton machines double truck, eight wheels, for heavy work; operate successfully on shortest curves, enter rooms without interfering with room necks or walls, and without derailing the cars or locomotive. The 6 ton heavy duty locomotive shown in cut can go anywhere in the mine that a mule will go, and develop draw-bar pulls of over 3,000 pounds and have minimum clearance dimensions.

Locomotives will show highest economy, hauling maximum tons of coal per day, due to their small bearing losses (using ball-bearings throughout), and use of two motors in series—parallel connection through controller.

Open, accessible frames secure ventilation and ready access to all parts for inspection or adjustment, thus making it unnecessary to dismantle machine. A single 4-ton locomotive has replaced eight mules and five drivers and has been in continuous service for over two and one-half years.

Lakewood Trolley Locomotives

Are made in 3 and 5 ton sizes for gathering work, using rugged plate steel frames, high efficiency series motors, and ball-bearings throughout, thus securing continuous, efficient service and smallest repair bill.



Mancha Storage Battery Locomotive Co.

General Offices & Works
ST. LOUIS, MO.

Manufacturers of Storage Battery Locomotives

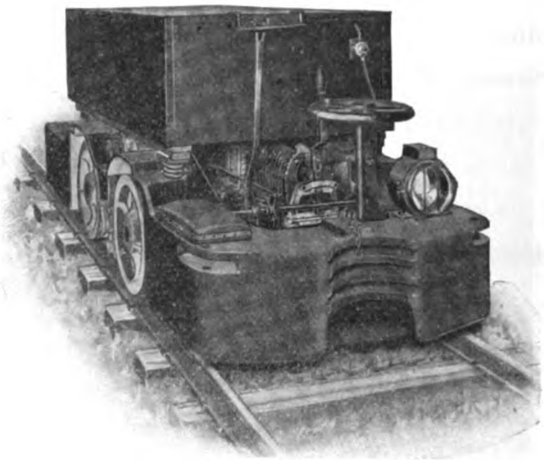
Products
Electric Storage Battery Locomotives.

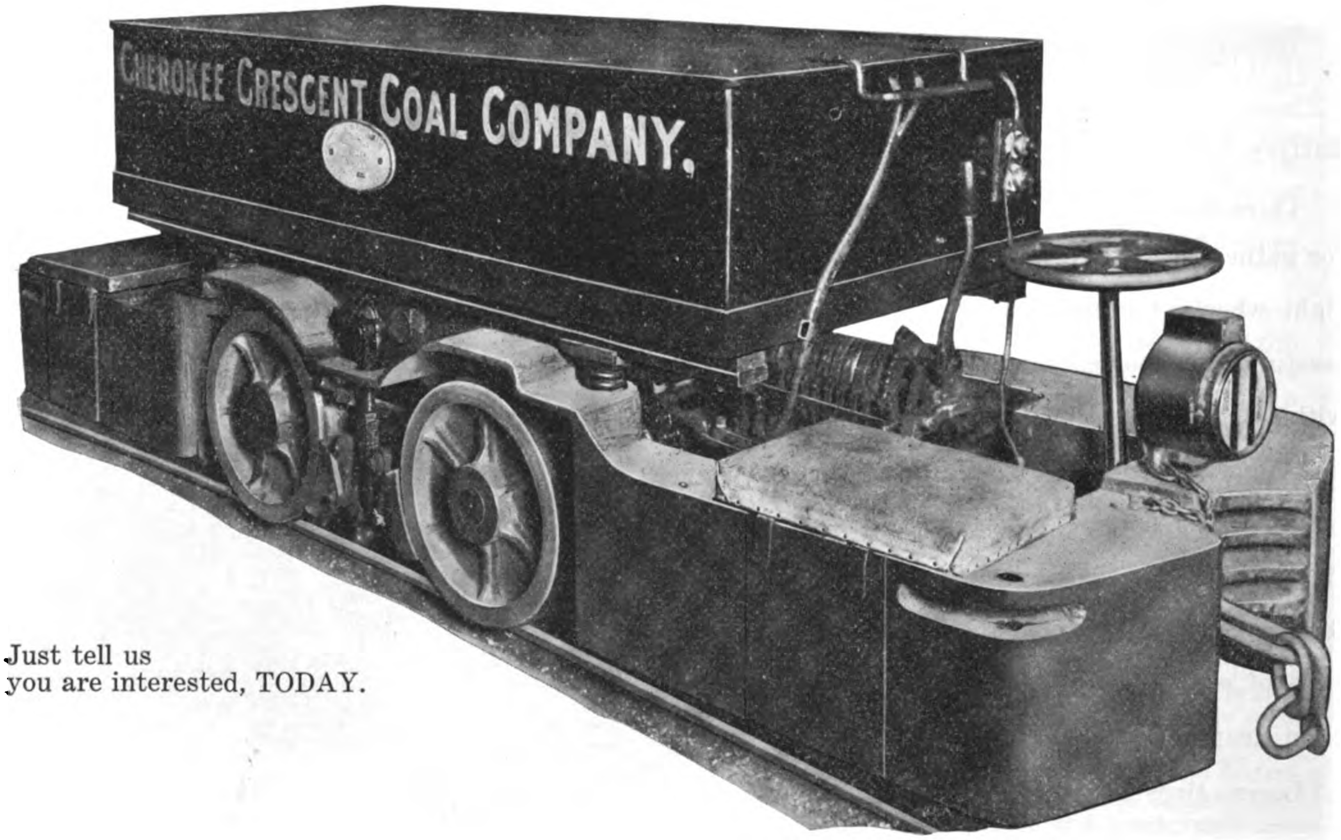
The cost of gathering and haulage of coal in coal mines has been reduced to a minimum by the installation of

"MANCHA'S ELECTRIC MULE."

The illustration below shows our locomotive in a mine where old mine mules did the job for a long time with considerable waste of time and money, so our Electric Mule was put in on trial, and just as we expected, it proved more economical from every angle—installation, maintenance, operation and care.

This is but ONE instance where Mancha's Electric Mules have shown marked success. We will be glad to tell you of numerous other instances, and to offer you an opportunity of trying out the Electric Mule in your mine at OUR cost.





Just tell us
you are interested, TODAY.

GEO. D. WHITCOMB CO.

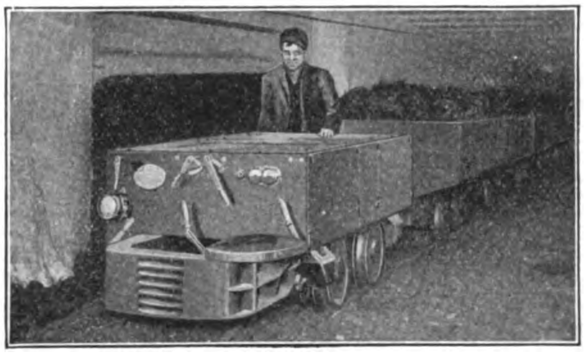
Main Office and Works
ROCHELLE, ILL.

Sales Offices
Pittsburgh, Pa. Wilkes-Barre, Pa. Ashland, Ky. Birmingham, Ala.
Denver, Colo. Seattle, Wash.

Electric Storage Battery Locomotives

The Coal Mining trade has been looking for a self contained haulage locomotive for gathering work.

The Storage Battery Locomotive is well adapted for this work as it can be charged at night when there is a surplus of power and is available for use during the day shift without drawing on the power.

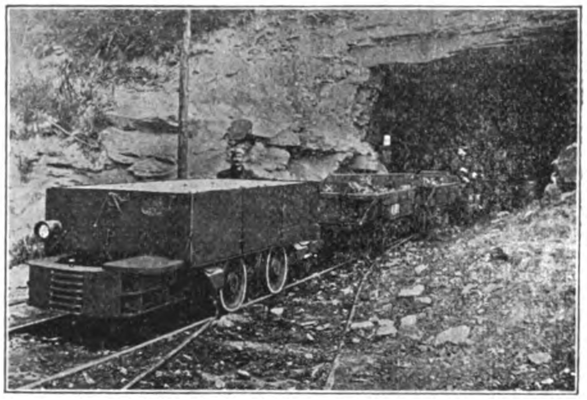


A Storage Battery Locomotive does not require trolley line, rail bonds, cables or other equipment to enable it to go to the working faces and gather the cars to the side tracks or switches for the main haulage motors. They are exceptionally useful in the development of a new mine for these reasons: As the power all has to be stored in the batteries they are only adapted for moderately short hauls and a combination of Storage Battery Motors for gathering and Gasoline Locomotives for the main haul makes an ideal combination, as both are independent units free from power plants and transmission lines.

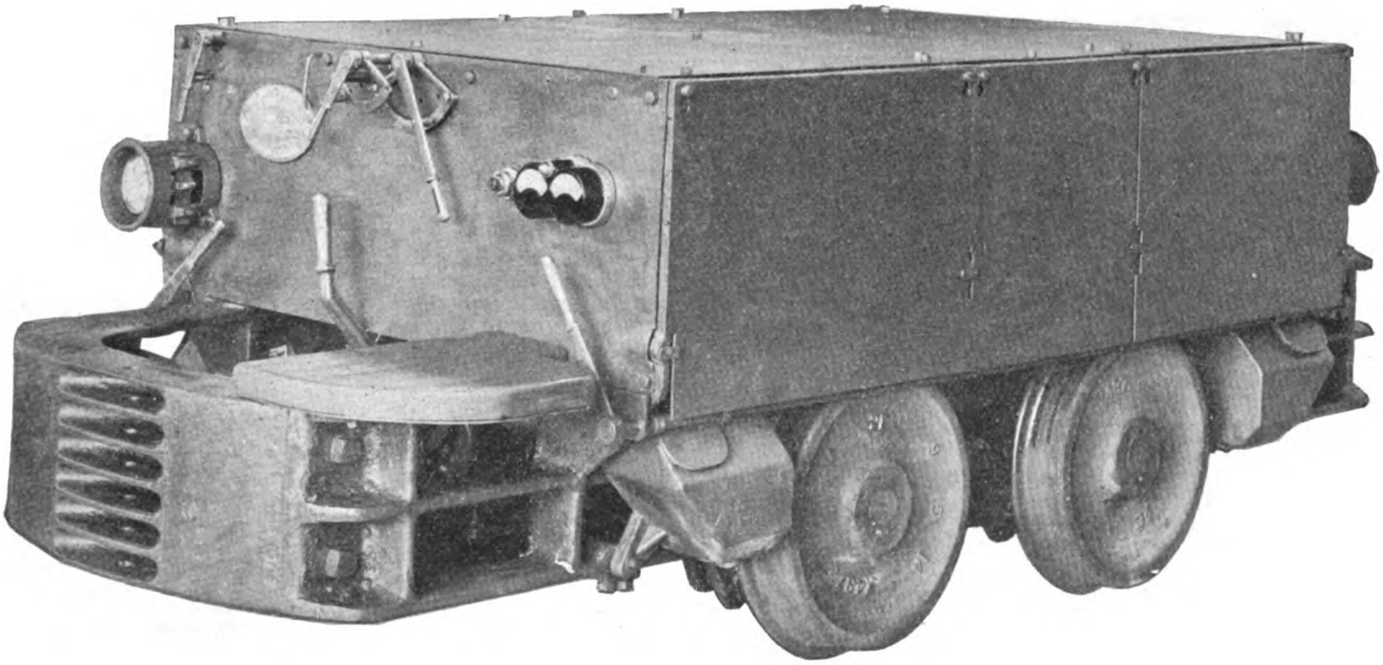
The Whitcomb Electric Storage Battery Locomotives are made in two types—a low type that is 32 inches in height for use in low coals and a higher type that is 42 inches in height for higher coals. The width and length will vary according to battery equipment.

In the installation of Storage Battery Motors it is necessary, to a large extent, to take each installation as a special engineering problem and proportion the battery equipment for the work to be done. Therefore there is no fixed or standard battery equipments.

The Whitcomb Electric Storage Battery Locomotives are built in weights from two tons to seven tons and with Battery equipment designed to give full eight to ten hour service on one charge of the batteries.



Correspondence is solicited and experienced men will be sent to go over conditions and submit full detailed estimates.



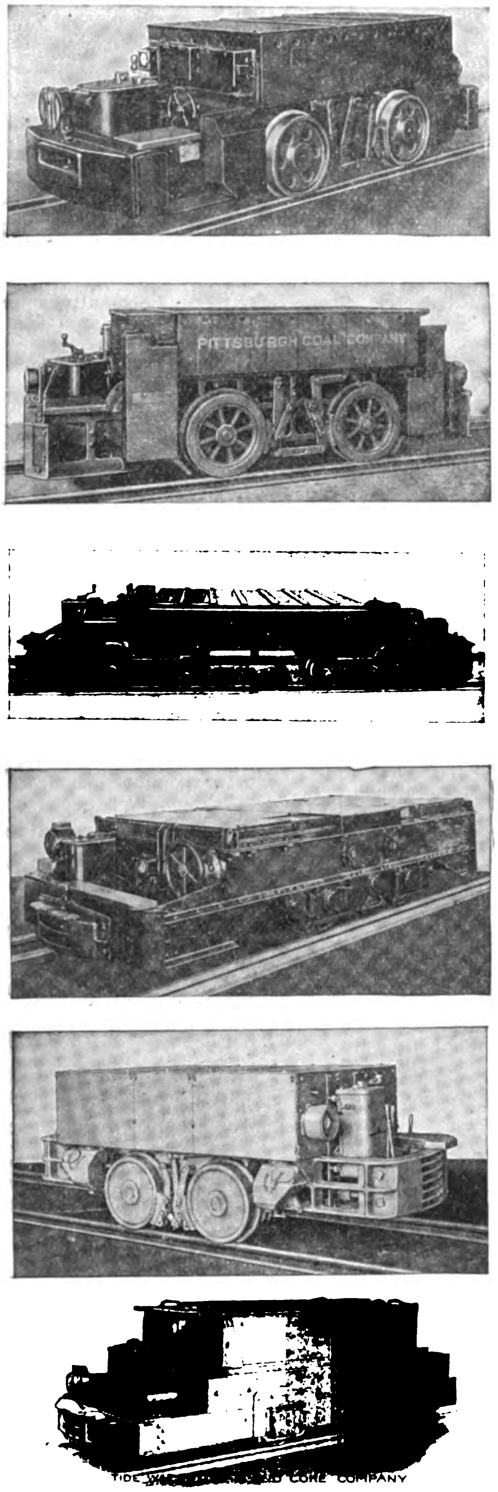
Edison Storage Battery Company

Factory and Main Office

232 LAKESIDE AVENUE, ORANGE, N. J.

Distributors in

NEW YORK BOSTON CHICAGO DETROIT PITTSBURGH
SAN FRANCISCO LOS ANGELES SEATTLE NEW ORLEANS



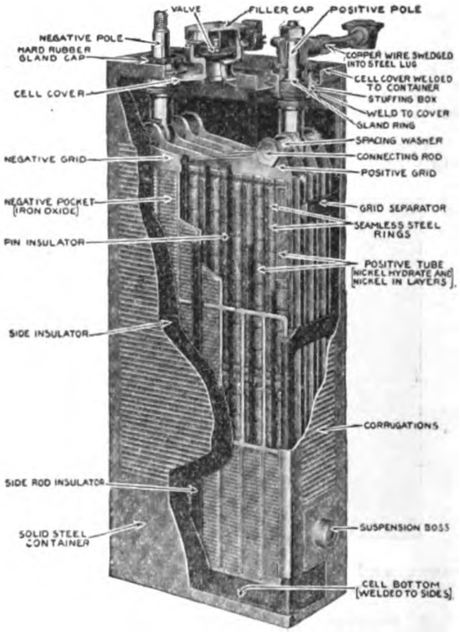
The different types and makes of Storage Battery Locomotives shown above use Edison Storage Batteries.

Edison Storage Batteries for use in Storage Battery Locomotives

The rough and hard service that Storage Battery locomotives undergo in mining work demand the qualities of strength, ruggedness and permanance in storage batteries. Edison Storage Batteries meet every requirement of this severe service.

The wonderful steel-and-iron construction of the Edison Battery gives it remarkable mechanical strength and ruggedness; the distinctive nickel-iron-alkaline principle insures electrical strength and long life of the chemical elements.

Today there are many Edison Batteries that are giving full rated capacity after five, six and more years of reliable, continuous work, without replacement of plates and with practically no repairs.



A Masterpiece of Mechanical Construction.

A few of the exclusive advantages resulting from its distinctive characteristics, follow:

It is light in weight.
The steel container is unbreakable.
It suffers small loss of charge when idle.
No frequent hydrometer readings are necessary.
The tray assembly and cell connections are simple.
Severe vibrations and concussion have no effect upon it.
It steadily increases in capacity for the first eight or twelve months.
Temperature of electrolyte may rise to 115 degrees Fahrenheit without harm.
Sulphation and kindred "diseases" like buckling or growing of plates, are impossible.
It may be boosted at high rates, several times normal rate being safely recommended for short periods.
It is hermetically sealed except for the single filler opening — no plate removals, no wood separator renewals or other repairs needed.
It may be left standing idle, either charged or discharged, for months at a time without injury and with absolutely no attention.
It gives off no noxious fumes and can be placed in any environment without fear of corroding nearby metal or injuring persons in the neighborhood.
It can be put on charge at any time, regardless of how little or how much of the previous charge has been used and similarly, it may be taken off charge at any time and used, whether fully charged or not.
No expert battery man is required to handle an Edison battery. Your mine electrician can secure the very best of results.
The Edison cell to cell connectors are made of copper and are practically unbreakable. No lead strap to burn out with subsequent delay and expense incident to their repair.
Accidents that are bound to occur occasionally, as, for example, short circuits, continued overcharges, charges in the reverse direction, excessive "boosting", or charging at too low a rate, have no permanent effect upon its life.

Write for a copy of Storage Battery Locomotive Bulletin No. 608.

The Electric Storage Battery Company

General Offices and Works:
Philadelphia, Pa.

PHILADELPHIA
Allegheny Ave. and 19th St.
NEW YORK
100 Broadway.
CHICAGO
Marquette Building.
ATLANTA
Baker and Peachtree Sts.
ROCHESTER
184 Clinton Ave., South.

ST. LOUIS
H. B. Marshall,
Soliciting Agent,
Federal Reserve Bank Bldg.
KANSAS CITY
H. B. Marshall,
Soliciting Agent,
17th & Walnut Sts.
DENVER
G. D. Luther,
Soliciting Agent,
1424 Wazee St.

WASHINGTON
1828 L St., N. W.
BOSTON
718-720 Beacon St.
CLEVELAND
Citizens Bldg.
PITTSBURGH
Keystone Building.
DETROIT
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MINNEAPOLIS
P. G. Downton,
Soliciting Agent,
3-5 North 15th St.
SAN FRANCISCO
George Murphy,
Soliciting Agent,
1536-1556 Bush St.
CANADA
The Canadian Gen'l Elec. Co.,
Ltd., King & Simcoe Sts.,
Toronto.

The "Ironclad-Exide" Battery for Storage Battery Locomotives

The "Ironclad-Exide" Battery has been especially designed for use on storage battery mine locomotives.

The "Ironclad-Exide" Battery is not the ordinary lead battery and should not be confused with it. It is different in the design and construction of the plates and different in the details of assembly.

The positive plate of the "Ironclad-Exide" Battery is made up of a series of hard rubber slotted tubes which contain the active material, a section of one of these tubes, cut away, being shown in Fig. 1. The tubes are very finely slotted giving access to the electrolyte yet so fine that the active material cannot readily work its way out of the plate and pile up in the bottom of the jar. This illustration also shows the conducting core which strengthens the plate and with its projecting fins holds each tube in place.

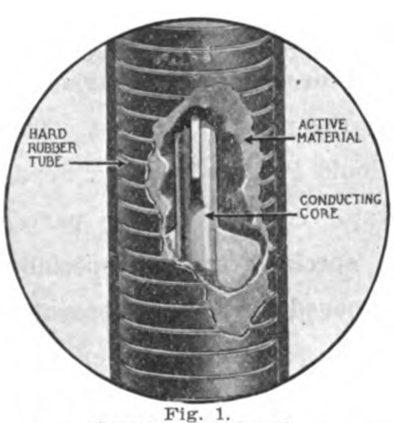


Fig. 1.
Section of Tube of
"Ironclad-Exide" Positive Plate.

Because of this special construction the "Ironclad-Exide" Battery gives two to three times the life of the ordinary lead battery, seldom, if ever, requires cleaning, and gives a greatly increased mileage.

The negative plates are of the approved "Exide" type properly designed to give approximately the same long life as the positive plates.

The "Ironclad-Exide" Battery has now been used for a sufficient length of time to prove the correctness of its design. Since its introduction it has been improved from time to time.

"Ironclad-Exide" cells are now equipped with a new type of cover giving many advantages not found in any other battery. Fig. 2 shows a sectional view of this new cover and filling plug.

This cover construction absolutely prevents dust or other impurities from getting into a cell and the cover being flush with the top of the jar leaves no space for the collection of moisture or dust. The special construction of the filling neck in the cover limits the amount of water that can be put into a cell to the exact amount needed to replace that lost by evaporation. This overcomes slopping and spilling of electrolyte, thus eliminating short-circuiting, corrosion, etc.

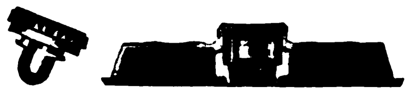


Fig. 2.
"Ironclad-Exide" Cover and Filling Plug.

The "Ironclad-Exide" Battery is assembled in special types of trays with cells securely blocked in place, thoroughly insulating the battery from the frame of the locomotive in such a way that it is well adapted to withstand the severe jars incident to frequent couplings or rough track.

This battery has been so simplified in its construction that it can be cared for, and good service secured from it, with very little attention, and such care as it does require can be given it by the workmen ordinarily employed at a mine. It does not require any special care or cleaning which necessitates its being periodically taken out of service.

The "Ironclad-Exide" Battery means not only better service and longer life but also less care and attention.

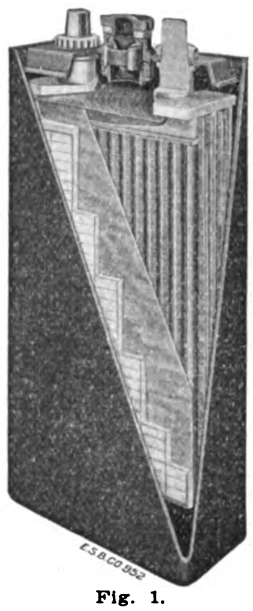


Fig. 1.
"Ironclad-Exide" Cell cut away, showing new cover, filling plug and splash cover.

The "Ironclad-Exide" Battery is being used in a large number of mines where it has been shown to give both efficient and economical results. It is used extensively on locomotives manufactured by the Atlas Car & Mfg. Co., Cleveland, Ohio; the General Electric Co. of Schenectady, N. Y.; the Jeffrey Mfg. Co. of Columbus, Ohio and the Westinghouse Electric & Mfg. Co. of Pittsburg, Pa.

Special catalogs, bulletins and instruction books on the "Ironclad-Exide" Battery can be secured from any Sales Office of the Company.

GOULD STORAGE BATTERY CO.

General Offices, 30 E. 42nd St., New York
Works, Depew, N. Y.

Philadelphia, 613 Lincoln Building.
Cleveland, 1765 E. 18th Street.
Detroit, 100 Beaubien Street.
Chicago, 225 East 22nd Street.
Los Angeles, 118 East Pico Street.
San Francisco, 1448 Van Ness Avenue.

Canadian Representative: R. E. T. Pringle, Toronto, Montreal, Winnipeg, Vancouver.

Gould
STORAGE BATTERY

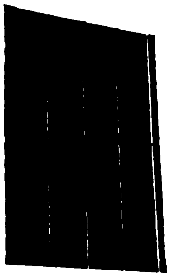
For Mine Locomotives

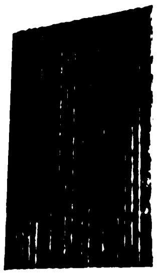
In the final analysis, the battery is the most vital part of the Storage Battery Mine Locomotive. If the battery fails—the locomotive fails.

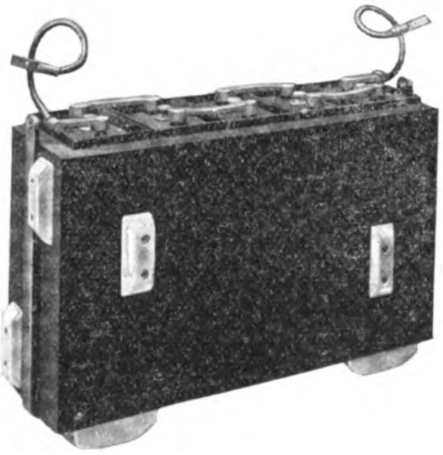
Records show that Gould Mine Locomotive Batteries have behind them, an unbroken line of successful service. The many Gould-Battery-Equipped Locomotives have demonstrated the remarkable ability of Gould Storage Batteries to "stand up and deliver" under the rigorous service of mine locomotive work.

The reasons are self-evident. Gould Mine Locomotive Batteries are not reconstructed vehicle batteries. They are designed and built expressly for mine locomotive work.

A distinctive advantage of the Gould Mine Locomotive Battery is the Gould Super-Hard Paste Plate. Unlike the soft paste composition that has a tendency to loosen and become dislodged—thereby diminishing the battery capacity—the Gould positive plate contains a very hard and closely bound active material, insuring, not only an extremely long battery service, but high sustained capacity practically undiminished throughout its life. This is one reason why the Gould Mine Locomotive Battery has a life two to three times as long as the ordinary lead battery under the rough service conditions of mine locomotive work.


The perforated ribbed rubber element of the Duplex Separator.


The specially treated, specially grooved, hard wood element of the Duplex Separator.



Almost of equal importance as plate construction, is the design and construction of the plate separators. The Gould Patented Duplex Separator consists of two parts; a specially treated, specially grooved hard wood separator and a perforated rubber separator with ribs which engage in the slots of the wood separator. This combination, further reinforced by the wide edges of the rubber separator, holds the wood separator securely and prevents warping—resulting in a plate separator with an extremely long life.

Gould Mine Locomotive Batteries are today operating most of the Storage Battery Mine Locomotives in use—substantiating proof of Gould inbuilt quality.

Write our nearest sales office for full and complete literature and let our engineers confer with you gratuitously on your battery requirements.

Philadelphia Storage Battery Company

General Offices and Factory

ONTARIO & C STS. PHILADELPHIA, U. S. A.

PHILADELPHIA DIAMOND GRID BATTERY

BRANCH OFFICES AND DEPOTS IN ALL LARGE CITIES

Atlanta, Ga.
128 W. Peachtree St.

Chicago, Ill.
1621 S. Michigan Ave.

Cleveland, Ohio
613 Citizens Bldg.

Huntington, W. Va.
Hotel Huntington

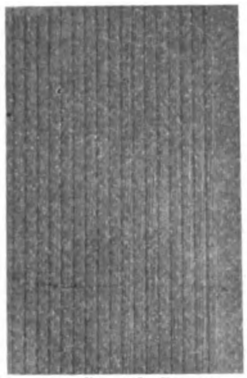
Philadelphia Diamond Grid Batteries

The prime requisite for satisfactory results in an electric locomotive storage battery is ability to deliver CONTINUOUS SERVICE. The Philadelphia DIAMOND GRID Storage Battery by virtue of several exclusive features of design DOES deliver continuous serivce, and our plan of having competent sales engineers on the ground, not only to sell batteries, but also to give service and keep them sold, assures Locomotive owners of this continuous service.

The Separator

Philadelphia DIAMOND GRID Locomotive batteries are built as rugged as we know how to build them. As illustrated, the separators (plate insulators) are made of hard wood, **quarter sawed** and specially treated. They last as long as the plates themselves. It is never necessary to dismantle Philadelphia batteries for change of separators.

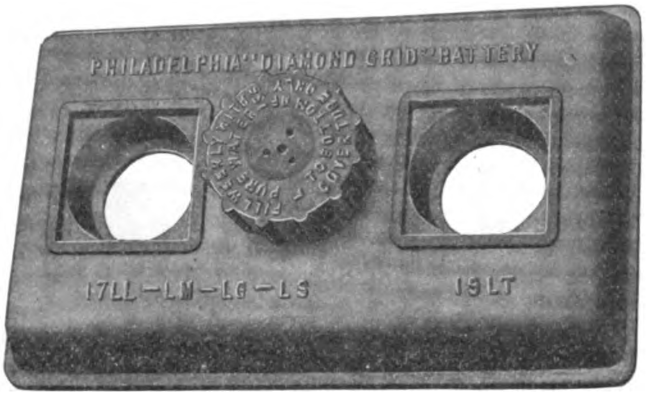
High rib jars accommodate all the sediment. It is never necessary to dismantle Philadelphia batteries for removal of sediment.



Quarter Sawed Separator.

Cover

Sloppage of acid, rotting of trays and jar breakage are eliminated by installing jar covers as illustrated below. All connectors are designed especially for locomotive work, and will not break or burn no matter how severe your operating conditions may be. Trifling troubles which mean delays with consequent loss of time and reduction of tonnage are unknown where Philadelphia DIAMOND GRID batteries are installed.

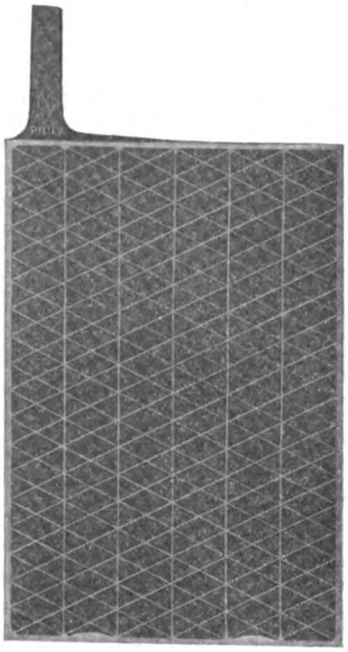


Cell Cover.

The Diamond Grid

All Philadelphia plates are built upon the patented DIAMOND GRID. As shown in the illustration the DIAMOND GRID consists of members arranged similarly to the members of the familiar bridge truss. This construction is used so universally by engineers, where great mechanical strength is desired, that no argument is necessary to demonstrate its desirability in a storage battery grid. The DIAMOND GRID will not break, will not buckle, will not short circuit.

The capacity of the usual DIAMOND GRID Locomotive Battery, Type WI, is as great or greater than the capacity of the ordinary locomotive battery, nevertheless still greater capacity may easily be obtained when desired by using Type WMI or WTXI. For instance a 48-21 WI will deliver 315 ampere hours. A 48-25 WMI will fit the same space and deliver 360 ampere hours. A 48-33 WTXI will deliver 408 ampere hours. Unusual requirements can thus be easily met or the original equipment can be converted into a higher capacity equipment by renewing with one of the higher capacity types.



Diamond Grid Plate

Philadelphia DIAMOND GRID Batteries have successfully met every service demand, from the lightest electric pleasure vehicle to the heaviest commercial tractor. For day in and day out service, and for the lowest cost per mile and per day, the Philadelphia DIAMOND GRID Battery stands pre-eminent.

Ninety percent of all electric pleasure cars built today are equipped by the manufacturers with Philadelphia DIAMOND GRID Batteries and any locomotive manufacturer will furnish Philadelphia batteries if specified.

Send for our bulletin on Locomotive batteries.

THE BALDWIN LOCOMOTIVE WORKS

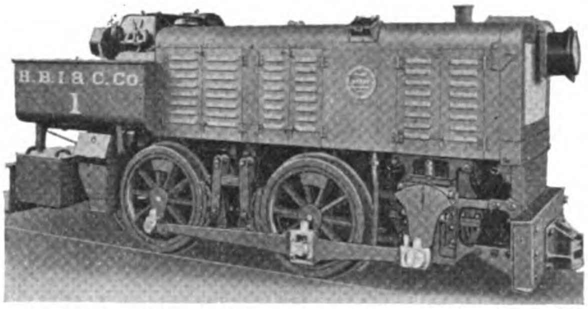
PHILADELPHIA, PA., U. S. A.

REPRESENTED BY

F. W. Weston, 120 Broadway, New York, N. Y.
Charles Riddell, 627 Railway Exchange, Chicago, Ill.
C. H. Peterson, 1210 Boatmen's Bank Building, St. Louis, Mo.
George F. Jones, 407 Travelers Building, Richmond, Va.
A. Wm. Hinger, 512 Northwestern Bank Building, Portland, Ore.
Williams, Dimond & Co., 310 Sansome Street, San Francisco, Calif.

Locomotives

Gasoline Locomotives
are suitable for light hauling and switching in and about coal mines. Under favorable conditions, they are perfectly safe for underground service. The following table contains particulars of the principal sizes built by The Baldwin Locomotive Works.



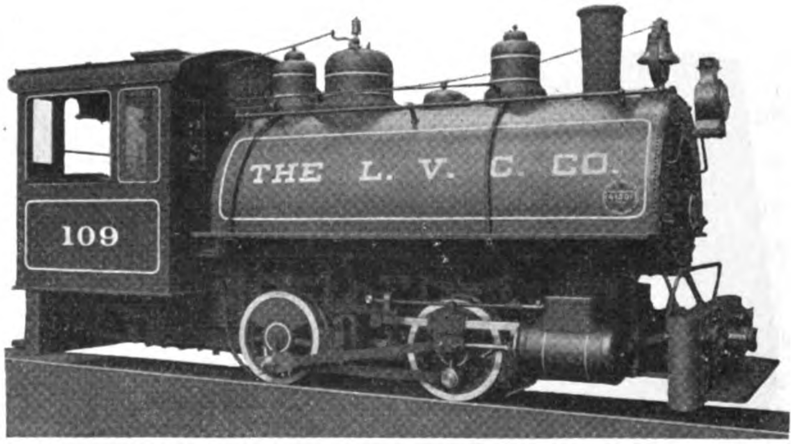
7-Ton Gasoline Locomotive.

Weight of locomotive in lbs..	7000	10000	14000	18000	46000
Number of cylinders	4	4	4	4	6
Diameter of cylinders, inches	4½	5	5½	6½	7¾
Stroke, inches...	5½	6	7	8	12
Draw-bar pull in pounds with high gear, on level track	750	1100	1600	2100	4700
Draw-bar pull in pounds with low gear, on level track.	1700	2400	3500	4400	10000

The minimum gauge for the first three sizes is 24 inches, and for the 9-ton size, 30 inches; while the 23-ton size cannot be built for less than standard guage (4′ 8½″).

These locomotives are simple in design and strongly built, and are proving reliable in severe industrial and contractors service. Record No. 85 contains full particulars.

Baldwin Steam Locomotives
include a number of designs that are fitted for mining work. The type illustrated is specially suitable for switching service where sharp curves must be traversed. It can be built for either narrow or standard gauge, in sizes ranging from 5 to 60 tons weight. Locomotives of this type have been built with inside cylinders, thus reducing the width so that they can pass through narrow entries. It is recommended, however, that the use of steam locomotives be confined to out-door work, except in the case of mines which are free of gas.



20-Ton Steam Locomotive.

Catalogues describing steam locomotives will be furnished on request.

H. K. PORTER COMPANY

1200 Union Bank Building

PITTSBURGH, PA.

BUILDERS OF

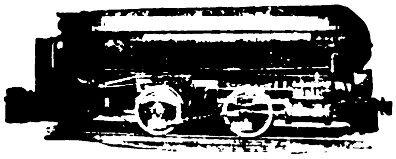
Steam and Compressed Air Locomotives

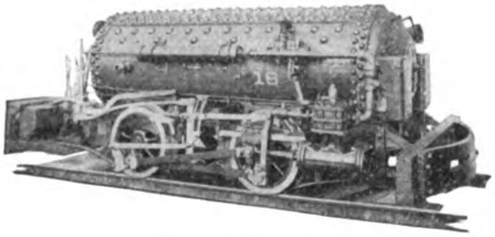
Products

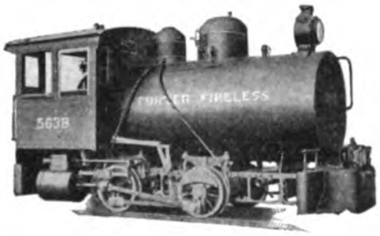
Steam Locomotives, light and heavy, narrow and wide gauges; Fireless Steam Locomotives; Compressed Air Locomotives, and Haulage Plants.

Porter Air Haulage for Underground or Surface

by utilizing the heat of the surrounding atmosphere—whether zero or tropic weather—gets 50 per cent more work out of the same quantity of air without a cent of additional cost—it is "free as air." This cuts down cost of compressor and storage pipe-line and cost of operating and has put old style single expansion haulage out of competition. The Porter patents have been sustained by the court of final appeal.

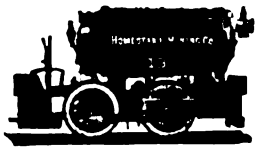

Two-Stage Air for Main Entry.


Two-Stage Air for Gathering.


Fireless Stored Steam.

Air Haulage is **free from fire risk** — no sparks — no live wires—no gas, smoke or fumes—no short circuits—improves ventilation—easy to operate—economical because **power produced evenly and constantly and** used as required.

Steam Mine Locomotive.


Two Stage Air to Go In Mine Cage.

Let us make estimate on plant complete designed to meet your conditions with highest efficiency and greatest economy. It will cost you nothing and save in money and safety. **Catalogue (a complete air textbook) on request.**

Contractors or Steel Mill.

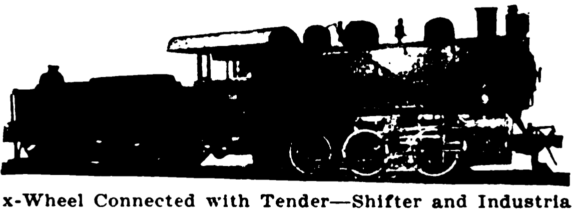
Porter Steam and Fireless Locomotives

TWELFTH EDITION STEAM CATALOGUE, 152 pages, 8 x 11, describing 673 sizes and designs, "the best locomotive catalogue ever printed," with engineering data, metric tables and information not elsewhere in print, free to intending purchaser, user, or to others at nominal price of $1.00.

Six-Wheel Connected with Saddle-Tank.

Steam locomotives—24, 36 and 56½ inch gauges, various designs, light and heavy sizes, always in stock completely finished, or for extra quick shipment.

All locomotives to duplicate system and spare parts always in stock ready to ship—a practical customers' accident insurance.


Six-Wheel Connected with Tender—Shifter and Industrial.

VULCAN IRON WORKS

WILKES-BARRE, PA

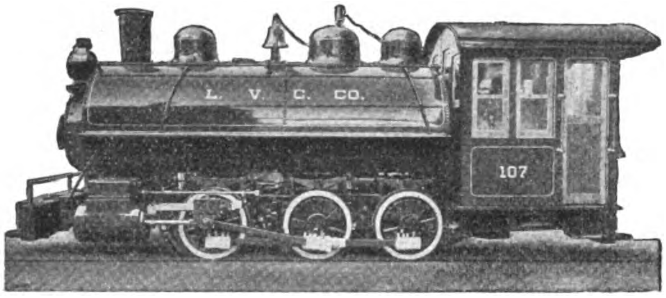
NEW YORK CHICAGO

Vulcan Steam, Gasoline and Air Locomotives; Steam and Electric Hoists; Mine Ventilating Fans

Products

See page 387.

Vulcan Mine Locomotives are of three distinct classes, steam, compressed air and gasoline, but in each type the time tried features of construction are retained. Especially is this noticeable in the double-bar frames, pedestal jaws, driving boxes, wheels and connecting rods.



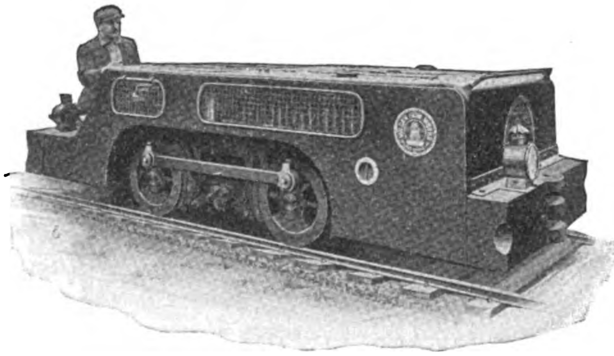
A typical 0-4-0 Vulcan for outside mine service. It combines large coal and water capacity with a short wheel base to negotiate sharp curves. These points and its high tractive power makes it a popular and efficient locomotive for mine shifting work.

In the Gasoline Locomotives four-cylinder opposed motors are used.

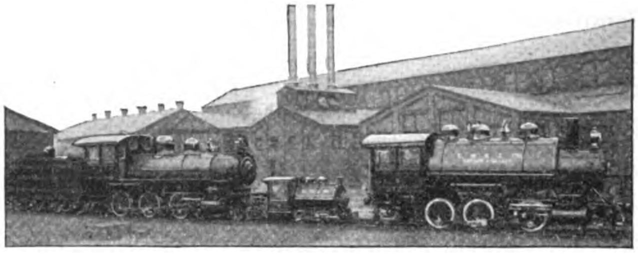
Vulcan locomotives of each class are made in a great range of size and tractive power to provide for widely varying conditions of service. But dependability in performance and maintenance are the governing principles in Vulcan design and construction.

Repair Parts

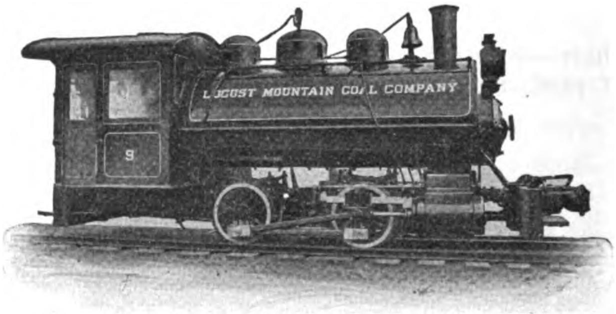
Repair parts for all Vulcan standard stock locomotives are nearly always on hand at Wilkes-Barre for immediate shipment. They are all made to gauge and template and are guaranteed to fit the proper locomotive class perfectly.



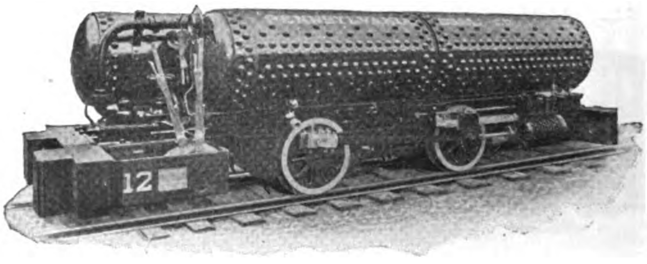
Gasoline Vulcans are made to exert draw-bar pulls up to 6000 lbs., which corresponds to the tractive force of an equivalent steam locomotive.



Even greater contrasts of size are possible in Vulcan Locomotives, but the midget with its clearance for mine work is built to the same exacting specifications as the largest one.



0-4-0 engines of this general type, with saddle-tank, are the best all around engines you can buy. We have countless designs made for special conditions. Unboubtedly one of these will fit your case exactly.



Hundreds of Vulcan Compressed Air Locomotives have been in successful service for years. Besides being absolutely safe in inflammable atmospheres, they add to ventilation.

Many people are amazed to learn that compressed air locomotives develop a tractive force greater than many steam locomotives of the same weight and cylinder dimensions.

THE J. D. FATE COMPANY

Factory and Office

401 RIGGS AVE., PLYMOUTH, OHIO, U. S A.

Manufacturers of

Plymouth Gasoline Locomotives

Products

Plymouth Friction Drive Gasoline Locomotives.

Drive

Gasoline motors do not develop their greatest power until they have reached their highest speed. Hence, if it is possible to give the disconnected motor sufficient gasoline to immediately attain its highest speed (its greatest power), to connect it with the transmission, we are applying full power to the traction wheels.

In the Plymouth Friction Drive transmission, two parts —the friction metal disc and the fibre-rimmed wheel take the place of the clutch or gear transmissions. To connect the motor with the traction wheels, a slight pull of the lever brings the friction disc against the fiber-rimmed wheel which is direct connected by a diamond steel roller chain to the front and rear axles. At any moment the Plymouth Friction Drive can be thrown in, and no matter if the locomotive is creeping on the slowest possible speed or up to its fullest speed, the motor is giving its full power all the time.

Advantages of the Plymouth Friction Drive

Starts under heavy loads quicker and without jerk or jump.

Climbs a steeper grade than any other locomotive of any type, as it can get away under full power, and speed may be changed at any point to adapt the locomotive to changing conditions.

Has limitless speeds—forward or backward. Power is exactly the same backward or forward.

There is no wasted energy, the locomotive pulling at full horse power at all speeds.

It does not slip under even the heaviest loads, there being less loss of power or transmission. The holding power is so great that the motor can be stalled with the throttle wide open.

It requires no lubricant whatever, except in the shaft bearings.

The only wear is in the fibre wheel, which will run several thousand miles, and the cost of replacing the fibre being less than the cost of a month's lubricants used by the ordinary gear transmission.

Construction and operation are the simplest of any locomotive built. Accessibility of all parts for cleaning, adjusting or replacing is a very strong point.

Motor

The Continental Motor is used in all the Model AL or three-ton Plymouth Locomotives, the usual gear case being removed, as the Plymouth Friction Drive Transmission takes its place.

The motor has four cylinders, 3½" bore and 5" stroke; is water cooled, and develops 23 H. P. at 1,000 R. P. M. and 34 H. P. at 2,000 R. P. M.

The Pittsburgh "Model Mogul Type" motor is used on the Model BL or six-ton Plymouth, this type motor being best adapted to the heavy duty locomotive.

The motor has four cylinders, 5" bore and 6" stroke; is water cooled by pump circulation and develops 50 H. P. at 1,000 R. M. P.

Hyatt Flexible Roller Bearings and New Departure Double Row Ball Bearings are used throughout the Plymouth.

Sizes and Types

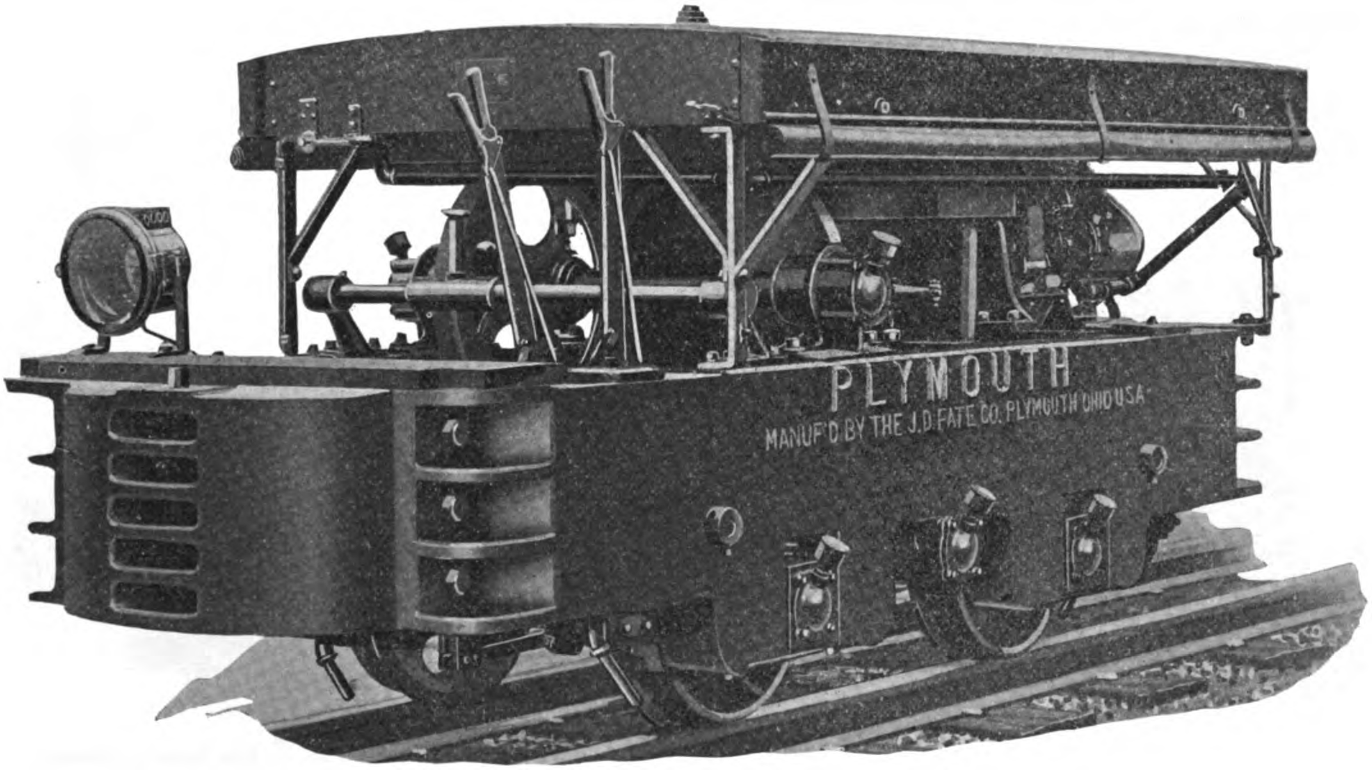
There are two sizes of the Plymouth, the AL 3-Ton Model and the BL 6-Ton Model.

The AL Model is built for track gages of 18 to 56½ inches. Height above rail (cabless type) is 58 inches. This may be reduced, by special construction, to 52 inches.

The BL Model is built for track gages of 30 to 56½ inches. Height above rail (cabless type) is 64 inches.

Reference

A list of users of Plymouth Locomotives will be sent immediately on recept of request. Our large list of prominent and satisfied users is our biggest asset.



MILWAUKEE LOCOMOTIVE MFG. CO.

General Office and Works
MILWAUKEE, WISCONSIN

Sales Office
PITTSBURGH, PA.
307-309 Westinghouse Bldg.

Sales Office
KNOXVILLE, TENN.
408 Bank & Trust Bldg.

Milwaukee Gasolene Locomotives

Milwaukee Gasolene Mine Locomotives represent the highest achievement in the practical application of gasolene motive power for track haulage.

Especially for mine haulage, where the requirements are most severe and where the nature of the work demands an equipment of the highest efficiency, Milwaukee Gasolene Locomotives will be found to possess many advantages over other forms of mechanical haulage.

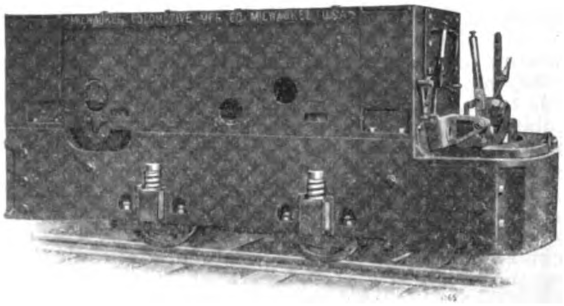
Their compact and sturdy construction, great flexibility, ease of operation and low cost of installation and maintenace, has made them important factors in the mining field, where they are now being used by many of the largest coal and metal mine operators as their sole form of motive power.

Being self contained units of power, they require no auxiliary power plant, overhead wiring, bonding of rails nor extensive pipe lines, with their attendant high cost of installation and upkeep.

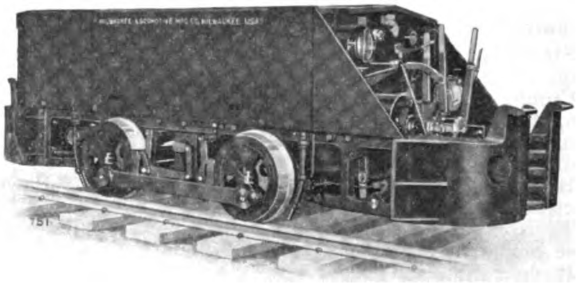
Milwaukee Gasolene Locomotives are now being extensively used in and around coal and metal mines, manufacturing plants, powder mills, brick yards, cement and fertilizer works, stone quarries, plantations, lumber mills, etc., etc.

We build them in various types for both mine and industrial service, in sizes of 2¼ tons to 8½ tons, for all gauges of track, and can furnish them equipped with canopy top, or cab when specified.

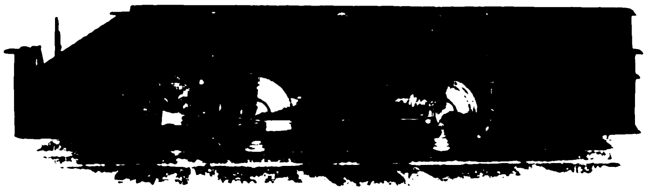
Write for Catalog L. 110.



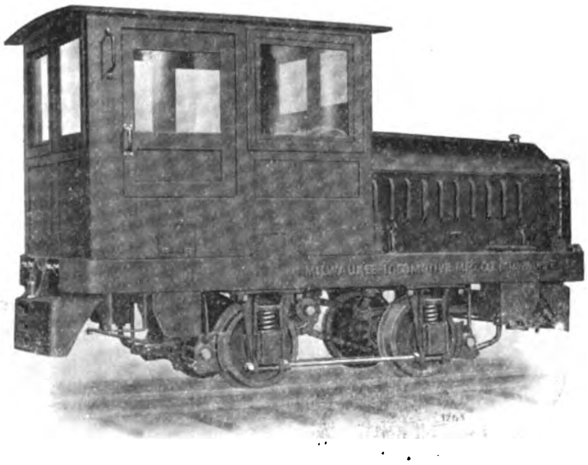
Type M-20
4¼ Ton Locomotive.



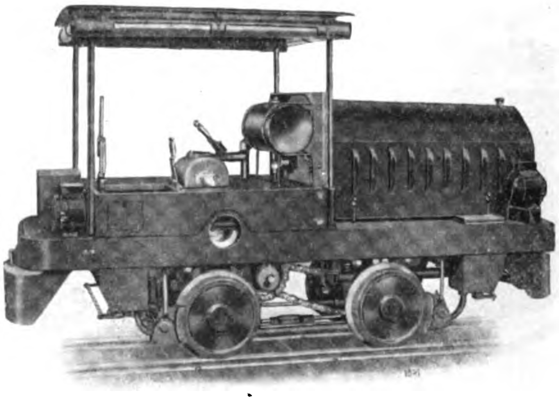
Type L-30
6 Ton Locomotive With Electric Lighting Equipment.



Type L-50
8 Ton Locomotive With Electric Lights and Starter.



Type W-20
3 Ton Locomotive With Cab.



Type WA-20
3½ Ton Locomotive With Canopy Top, Electric Lights and Starter.

GEO. D. WHITCOMB CO.

Main Office and Works
ROCHELLE, ILL.

Sales Offices
Pittsburgh, Pa. Wilkes-Barre, Pa. Ashland, Ky. Birmingham, Ala.
Denver, Colo. Seattle, Wash.

Gasoline Locomotives

Whitcomb Gasoline Locomotives have been in use in the United States in practical every day use since the Spring of 1910 and at the present time there are several hundred Locomotives in use. They are in service in Coal Mines, Limestone Mines and Quarries, Lead and Zinc Mines, Iron Mines and around industrial plants and can be used in any service where a self contained haulage Locomotive, free from dirt and smoke is desired.

In under ground work some provision has to be made for ventilation, but this is easy to provide.

The Whitcomb Gasoline Locomotive is driven by four cylinder four cycle heavy medium speed engines. The light automobile type of engine is not used.

The drive is by means of heavy roller chains, a double drive from jack shaft to front axle, and a single drive from front to rear axle making all four wheel drive wheels—thereby gaining the greatest tractive effort.

The cooling is secured by spraying the water into two cast iron cooling boxes and driving air through the spray by means of a Sirrocco Type Fan. The air coming in direct contact with the water giving highest efficiency. These boxes are easily cleaned and are not liable to injury like an automobile type radiator.

Transmission provides for two speeds in either direction, and the locomotive operates equally well in either direction. Ordinarily the low speed is four miles per hour and the high speed is eight miles per hour with the engine running at normal speed. The engine can be run both above and below normal speed therefore a range of speed from two miles to ten miles per hour is available.

The Whitcomb Gasoline Locomotive is built with wheels inside or outside of frame—with or without cabs—for all gauges of track from 18" to 56½", and in sizes from 2½ tons up to 16 tons in weight.

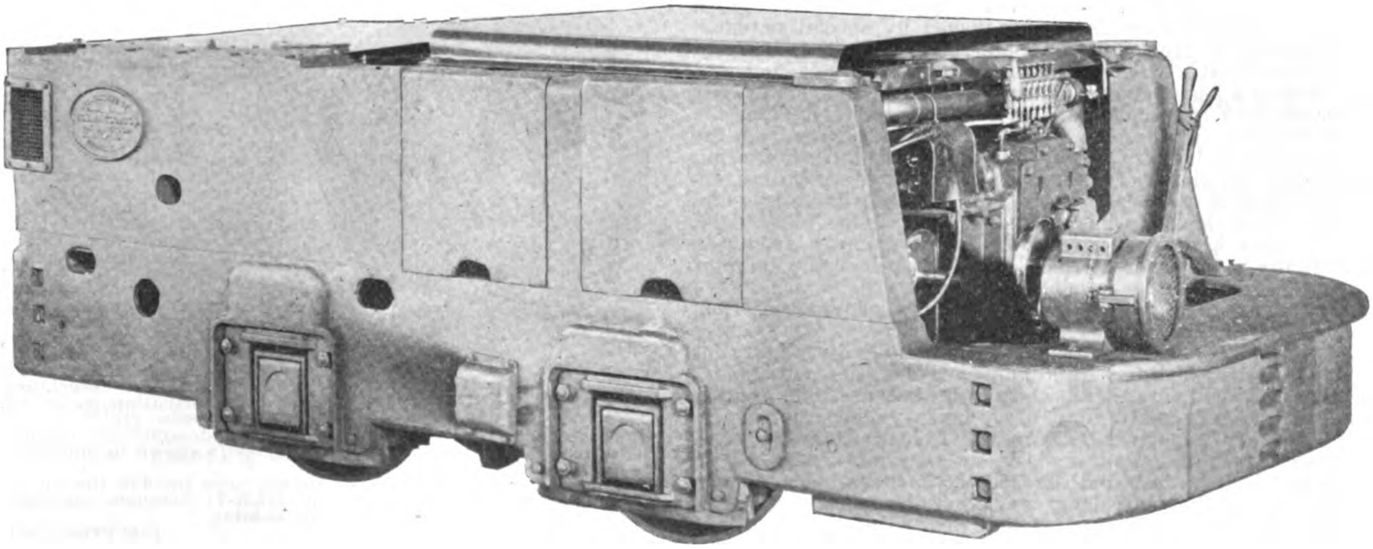
The locomotives will exert a tractive effort in starting equal to about 25% of the weight of the locomotive and will develope a constant draw bar pull on the level when working in low gear equal to 20% of the weight of the locomotive.

Based on a draw bar pull of 20% of the weight of the locomotive on the level, the hauling capacity in tons of 2000 lbs. per ton of weight of locomotive is as follows:

Rolling Friction or Resistance of Cars Per Ton Gross Weight on the Level.

	15lb	20lb	25lb	30lb	35lb	40lb
On Level	26.6	20.	16.	13.3	11.4	10.
Against ½ of 1% Grade	15.6	13.	11.1	9.7	8.7	7.8
" 1% "	10.8	9.5	8.4	7.6	6.9	6.
" 1½% "	8.2	7.4	6.7	6.1	5.7	5.3
" 2% "	6.5	6.	5.5	5.1	4.8	4.5
" 2½% "	5.4	5.	4.6	4.4	4.1	3.9
" 3% "	4.5	4.2	4.	3.8	3.6	3.4
" 3½% "	3.9	3.7	3.5	3.3	3.1	3.
" 4% "	3.3	3.2	3.	2.9	2.8	2.6
" 4½% "	2.9	2.8	2.7	2.6	2.5	2.4
" 5% "	2.6	2.5	2.4	2.3	2.2	2.1

Full estimates of cost of installation and operation will be submitted on request.



ELECTRIC SERVICE SUPPLIES CO.

Manufacturers of Railway and Mining Electrical Supplies
GENERAL OFFICES AND FACTORY:
17th and Cambria Streets, Philadelphia, Pa.

CHICAGO, ILL., Monadnock Bldg.
NEW YORK 50 Church Street
GEE ELECTRIC CO., Wheeling, W. Va.
GRAYSON RAILWAY SUPPLY CO., St. Louis, Mo.
ATLANTA, GA., 1526 Candler Bldg.
McCLARY-JEMISON MACHINERY CO., Birmingham, Ala.
LYMAN TUBE AND SUPPLY CO., LTD., Montreal. Toronto.

"Golden Glow" Incandescent Mine Headlights

"Golden Glow" Mine Headlights

"Golden Glow" incandescent mine locomotive headlights provide maximum illumination under all conditions encountered in mining service, combined with low current consumption and maintenance cost, thus offering the most efficient headlight for mine locomotive use.

"Golden Glow" mine headlights have certain valuable features which are the result of much scientific research and perfection. For example, it has been definitely proven, both theoretically and practically, that a greenish yellow light is the one in which the human eye operates at its highest efficiency and with the least strain, and that the violet and blue portions of the spectrum can be dispensed with without altering our ability to see distinctly and with an attending degree of comfort to the eyes.

It was with this in view that the famous "Golden Glow" parabolic reflector was developed. The mirrors, or reflectors, themselves are made from a peculiar golden green glass, accurately ground and polished by special patented machinery to true parabolic shape; they are then silvered like the finest French plate mirror, this silvering being protected by a heavy copper plating over same, and this heavily coated with a special paint to further protect it from the effects of moisture and temperature. Light passes from the incandescent lamp of the headlight into the mirror, passing through the glass before striking the silvered reflecting surface; in this passage through the glass the blinding white light from the lamp has subtrated from it the blue, violet and other high-frequency rays, and it emerges from the reflector as a powerful shaft of light as near the color of molten gold as it is possible to obtain; a light rich in the soft, non-blinding, greenish yellow rays of the spectrum. This light is the famous "Golden Glow."

"Golden Glow" light is not only a non-blinding light, but it is a light which has its illuminating qualities actually increased as compared with white light, because it is practically a monochromatic light of greenish yellow color.

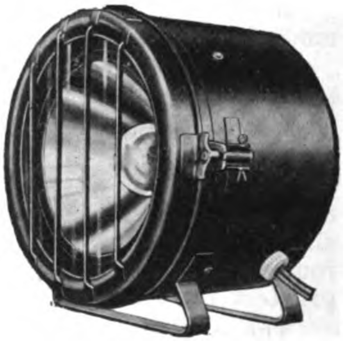
Another important feature of "Golden Glow" light of interest to mine operators is in its very marked ability to penetrate fog, dust and smoke. It has long been known that yellow light of long wave length penetrates foggy atmosphere better than a white light. When a white light strikes a fog-laden atmosphere, a large percentage is reflected back into the eyes of the observer, making it impossible to see for but a few feet ahead. In "Golden Glow" light, as has been explained, the violet and other high-frequency rays are purposely absorbed by the glass reflector, leaving the famous "Golden Glow," which suffers very little from absorption.

The light projected from "Golden Glow" mine headlights is, therefore, also the best light from the standpoint of safety, since it provides maximum illumination without the harmful or even disastrous effects a white brilliant light imposes on the eyes of workmen.

Write for catalog.

Type ML-74

"Golden Glow" Headlights type ML-74 being designed especially for mine use, have the reflector and socket flexibly suspended in the case, in order to prevent the vibration of the mine locomotive from breaking the lamp filament.



Type ML-74
Without Turret Base.

The case and all metal parts are of drawn steel, electrically welded and finished inside and out in baked black enamel. No castings whatever are used. The door is provided with a grid to protect the front glass.

Low operating costs are secured in these headlights by the use of 23 or 36 watt concentrated filament Mazda lamps in standard G-18½ round bulbs, having 1⅞-inch light center length, and satisfactory results cannot be secured from any other type or size of lamp. They may be connected in series with special resistances described and listed in our Catalog No. 110, or in series with other incandescent lamps on the locomotive. provided these lamps are of exactly the same current consumption and of the proper voltage.

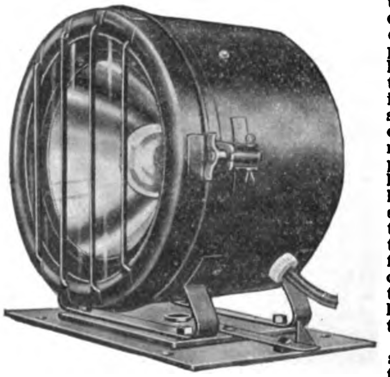
These headlights complete weigh approximately 13 pounds. Diagram giving all important dimensions is shown in catalog referred to above.

Prices on headlights do not in any case include the incandescent lamps, which are listed separately in our catalog. For listing of type ML-74 complete headlight equipments, refer to Page 5 of our catalog.

List No.		List Price, Each
19534	Type ML-74 headlight only	$30.00

Type MLR-74

"Golden Glow" Headlights type MLR-74 differ from the type ML-74 only in that they are provided with a turret base, which permits their revolution through an angle of 180 degrees, and thus on locomotives, where it is possible to operate the headlight from one position in both directions, it is not necessary to install more than one equipment for each locomotive. The bases are provided with a spring latch, which automatically locks the headlight in either position. Both types of headlights have the reflector and socket flexibly suspended in the case, in order to prevent the vibration of the mine locomotive from breaking the lamp filament.



Type MLR-74
With Turret Base

Other details of construction being identical to the type ML-74, refer to preceding description for information on lamps, resistances, etc.

These headlights complete weigh approximately 2½ pounds. Diagram giving all important dimensions is shown in our Catalog No. 110.

Prices on headlights do not in any case include the incandescent lamps. For listing of type MLR-74 complete headlight equipments, refer to Page 5 of our catalog.

List No.		List Price, Each
20283	Type MLR-74 headlight only	$38.50

GENERAL ELECTRIC COMPANY

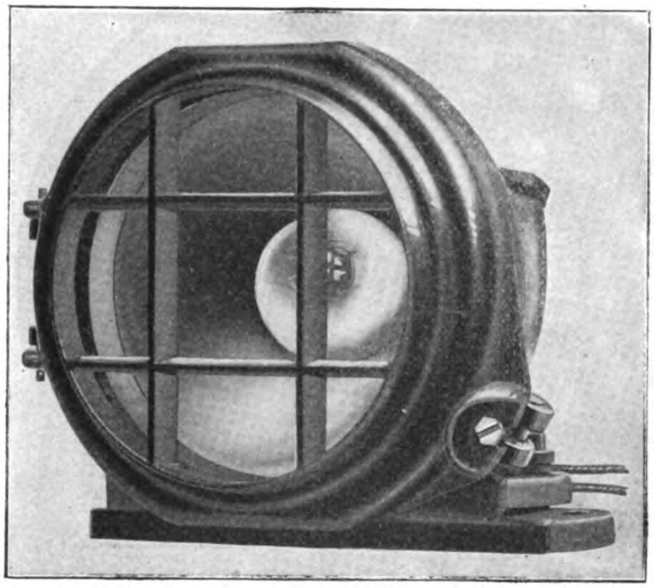
General Office:
Schenectady, N Y

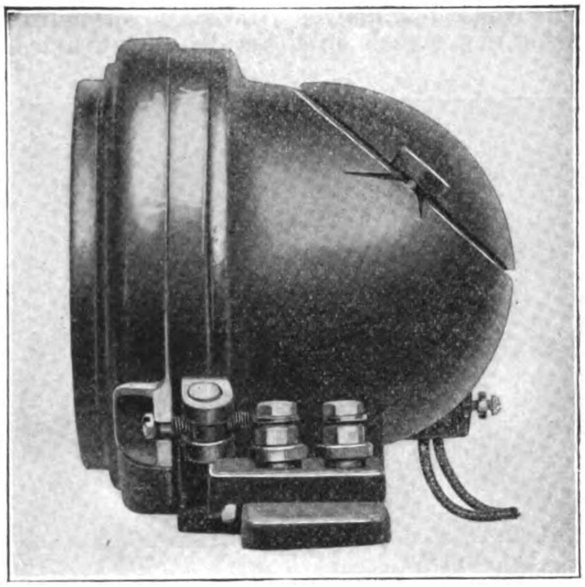
The Guarantee on Goods of Excellence Electrical

Sales Offices
In All Large Cities

Mine Locomotive Headlights

Form H²





The many novel features in the construction of this headlight places it far in advance of any other incandescent type.

When used with a 94-watt MAZDA lamp the "pick up" distance is from 500 to 600 feet.

Because of the shape of the case it is obvious that anything falling on it will strike a glancing blow.

Furthermore there are spiral springs to take up jar and shock, thus prolonging the life of the incandescent lamp.

The focusing device is readily accessible through a handhole in the top of the case.

This sturdy moisture proof headlight is not an adaption of an existing device; but one that has been designed throughout by engineers thoroughly familiar with every phase of mining operations.

PENNSYLVANIA CASTING & MACHINE WORKS

PITTSBURGH, PA.

Manufacturers

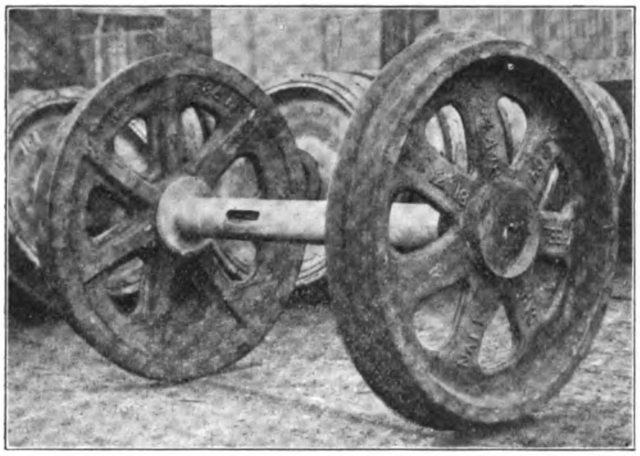
Wheels of Every Description

Products

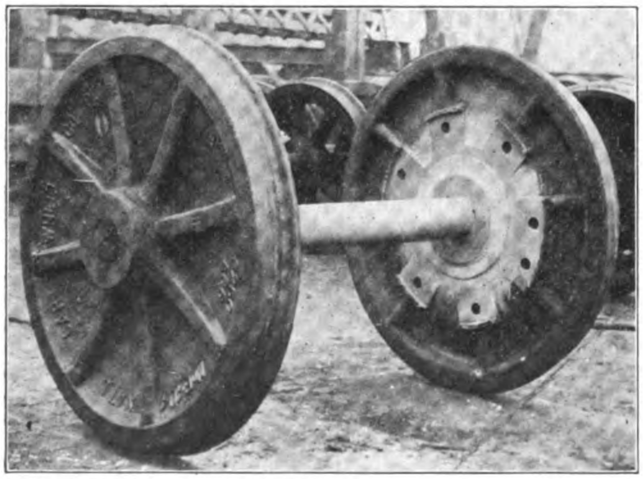
Wheels of every description for mining locomotives, dump cars and standard M. C. B. freight cars.

Our Facilities

We carry in stock at all times wheels and axles for all types and makes of mining locomotives, thus insuring you quick delivery. We also specialize in mounting new wheels on either old or new axles.



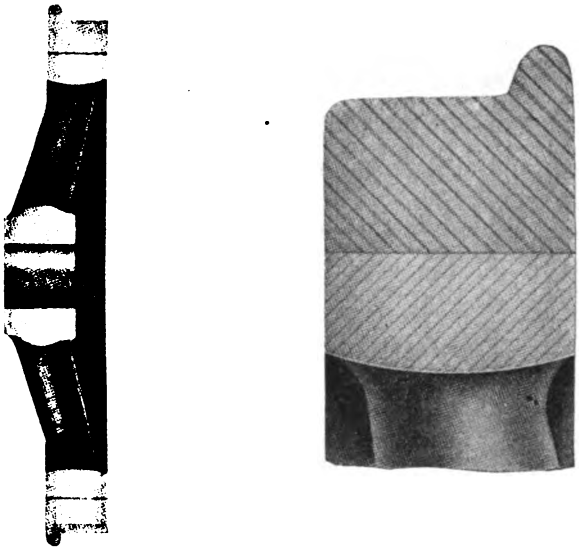
Baldwin, Westinghouse, Jeffrey, Morgan-Gardner Locomotive Wheels.



Goodman Locomotive Wheels.

Steel Tired Wheels

We supply steel tired wheels complete, or can furnish steel tires properly machined for your refitting to old centers.

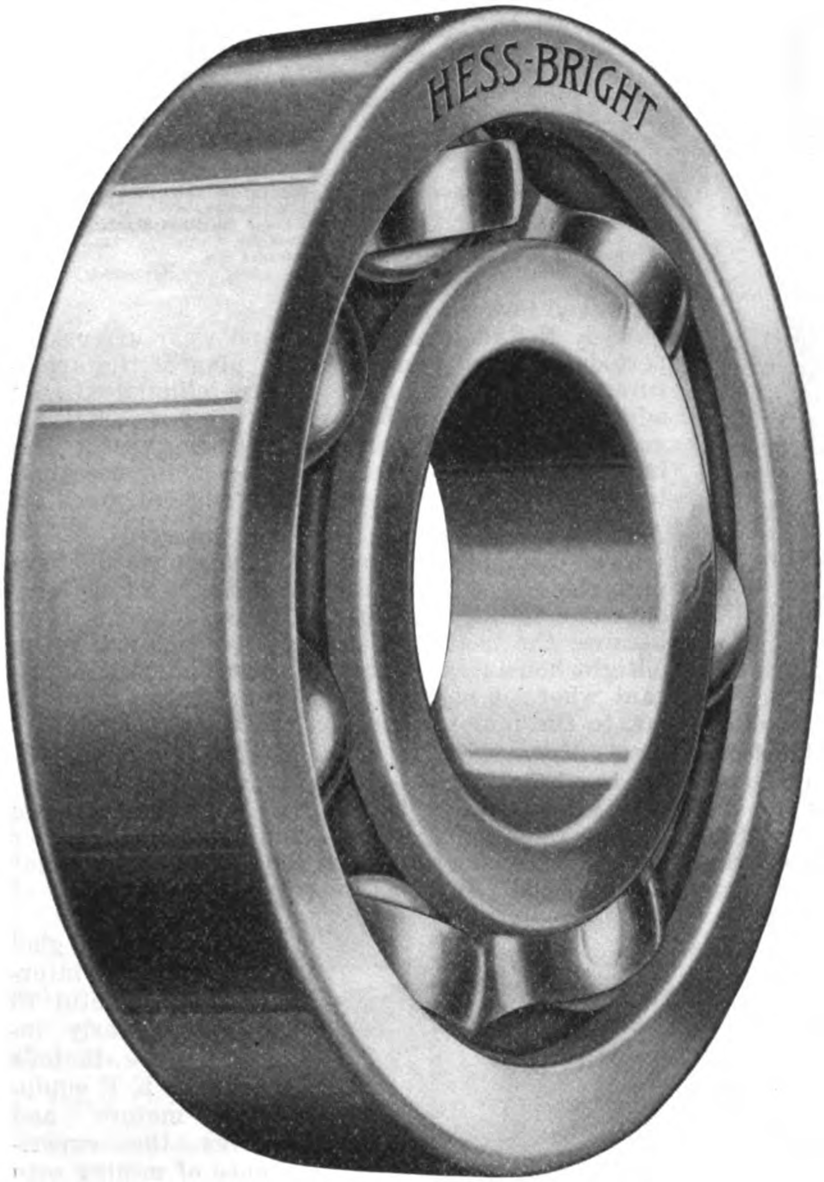


Write Us for Particulars.

The Hess-Bright Manufacturing Company

Front Street and Erie Avenue,
PHILADELPHIA, PA.

HESS-BRIGHT BALL BEARINGS



Hess-Bright Ball Bearings were the first anti-friction bearings to be used with success in the coal mining industry. Their instantaneous success led to their wide-spread adoption in this field.

Their success in maintaining constant the air-gap on the armature shafts of mining locomotives, through years of hard service, is remarkable. HESS-BRIGHTS installed in mining locomotive motors eight and nine years ago are still in service.

Construction of Hess-Brights

THE BALLS—a single row of generous size, roll between very heavy inner and outer rings and in groves of unusual depth.

THE CAGE—is of two-piece steel construction, well riveted together, and accurately fitted.

THE RACES—are of unusually section, heavy, affording grooves of twice the ordinary depth, in which the balls may roll.

When you buy mining locomotives specify that the motors shall be equipped with Hess-Bright Ball Bearings.

Hess-Bright's Conrad Patents are thoroughly adjudicated.

S K F BALL BEARING CO.

HARTFORD, CONN.

Ball Bearings for Mining Locomotives and Machinery

Products

Self-Aligning Ball Bearings for mine locomotives, coal cutting machinery, mine cars, mine fans, electric motors and generators.

Features

The S K F Ball Bearing consists of a double row of balls held by a suitable retainer between an outer and an inner race. As will be seen in Fig. I, the outer raceway is a section of a hollow sphere, whose center is on the axis of the shaft.

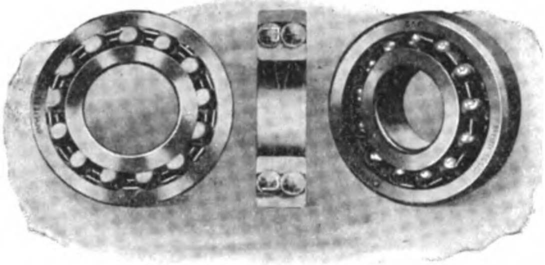


Fig. I.
S K F Ball Bearing, Normal, Sectional and Deflected Views.

This permits S K F Ball Bearings to compensate for any deflection of the shaft due to shock or sudden starting. Binding of the bearing is impossible.

The double row construction of S K F Bearings permits the use of nearly twice as many balls as are used in standard single row bearings of the same dimensions. This distributes the load more evenly and gives the bearing greater load capacity.

Advantages

When S K F Bearings are used in mining machinery many advantages are gained.

Additional Power In Same Space

The S K F Ball Bearing with a liberal lubricant chamber is less than half as long as a plain bearing for the same service. In some cases a ball bearing motor is twenty per cent shorter than a plain bearing motor of the same characteristics and capacity. The advantages of this feature are apparent. Higher powered locomotives can be built for narrow gauge track; coal cutting machinery can be made more compact; fans require less room; space can be saved in the design of tipples by using S K F equipped motors to drive the tipple machinery.

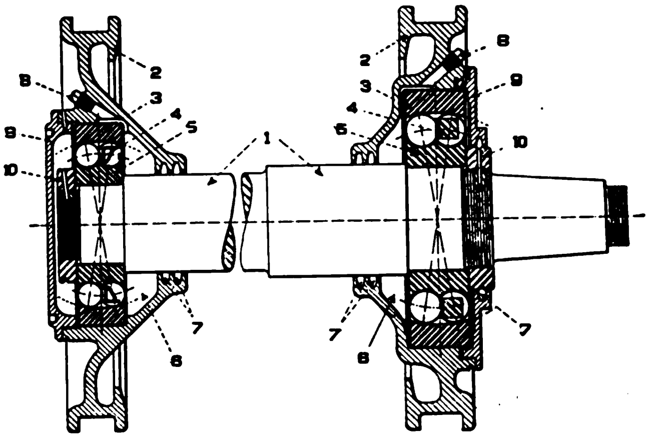


Fig. 2.—Mounting Arrangement of Mining Locomotive Motor.
1. Armature shaft.
2. Motor bearing head.
3. Outer bearing race.
4. Balls and retainer.
5. Inner bearing race.
6. Lubrication chamber.
7. Gland to seal lubrication chamber.
8. Grease feed pipe.
9. Outside housing cap.
10. Lock nut to hold inner race securely on shaft.

Improved Power Factor

S K F Ball Bearings show no wear after long periods of service and thus dropping of the armature, stripping and burnouts are eliminated. In addition, motors can be built with a very small air gap, because of the absence of bearing wear. This improves the power factor of the motor to a material extent, and makes a more efficient machine.

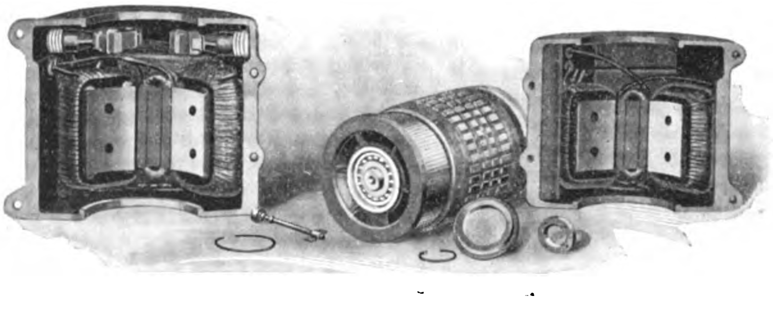
Armature and Commutator Are Protected

The commutator and the armature coils are protected from short circuits, sparking and burnouts due to oil, coal dust and "slop." This is so because the bearing is completely enclosed by an oiltight housing and sealing grooves keep the lubricant where it belongs. No oil or grease can leak out to the pinion casing or the armature. Fig. 2 shows this.

Higher Efficiency

By substituting S K F Ball Bearings for plain bearings sliding friction is eliminated. The power saved is considerable and engineers agree that S K F Ball Bearings increase the efficiency of motors materially.

We will be glad to send any information. Bulletin 70 is particularly interesting. It tells about S K F equipped motors and gives the experience of mining men with S K F Ball Bearings. It is sent free on request.



Mining Locomotive Motor, Disassembled, Showing S K F Ball Bearings.

STANDARD ROLLER BEARING CO.

SRB PHILADELPHIA, PA. SRB

SALES OFFICES

1852 Penobscot Bldg., Detroit, Mich.
2206 Michigan Avenue, Chicago, Ill.
822 Hume Mansur Bldg., Indianapolis, Ind.

SERVICE SALES DEPT. BRANCHES

163 Massachusetts Avenue, Boston, Mass.
2206 Michigan Avenue, Chicago, Ill.

MANUFACTURERS OF

SRB Maximum Type Annular Ball Bearings, Single Row and Double Row, as shown.

SRB Improved Type Taper Roller Bearings.

"Standard Alloy" Steel Balls.

Rudge-Whitworth Detachable Wire Wheels.

It is a fact and has been proven by conclusive tests for strength and endurance that S. R. B. Bearings are superior to any bearings made in America.

There are three fundamental principles upon which we base this claim of superiority, namely:

First. Accuracy of chemical composition of the steel used in their manufacture.

Second. Accuracy of heat treatment which produces the correct physical structure in the steel.

Third. Accuracy of mechanical execution in the grinding and fitting of all the component parts.

We stand ready to prove these assertions.

S. R. B. Maximum Silent Type Annular Ball Bearings are so called because no other name is so appropriately descriptive; maximum, because they contain the greatest number of balls possible to put into a bearing of this type; silent, because they are positively noiseless.

They are capable of sustaining greater thrust loads than other annular ball bearings because of four specific points of merit in their design and workmanship:

First. Deep ball groove in races.

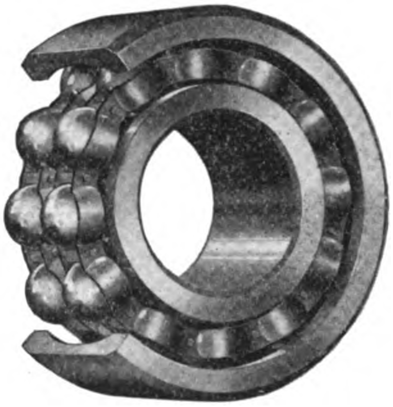
Second. Large diameter balls.

Third. Maximum number of balls.

Fourth. Accurate and snug fitting assembly.

S. R. B. Bearings are interchangeable with all other makes of annular ball bearings, either domestic or foreign; comparative table (form 9032) showing the most commonly used sizes will be sent upon request.

It has been frequently demonstrated that under some conditions one type of bearing works a tremendous saving over another. Certain other conditions sometimes develop which make one type of bearing impractical for the use intended. Under certain load conditions, a small bearing can be used very often with the same satisfaction and service as the larger one. Sometimes by making a slight change in application, according to the bearing maker's point of view, greater efficiency can be obtained.



You will find us always ready to solve such problems without bias and without charge, and we particularly urge the importance of consulting our Engineering Department in selecting bearings for any mounting. You will find our engineers qualified by training and experience to give expert advice on such problems, and by submitting your plans to us, sending if possible blueprints or sketches showing the application and giving complete information regarding speed, load and shaft size, you can be assured that most satisfactory results will be obtained.

S. R. B. Bearings are made to do their work with masterful efficiency.

R. D. NUTTALL COMPANY,

PITTSBURGH, PA.

Representatives

GEO. E. WATTS.
Chandler Bldg., Atlanta, Ga.
CHAS. N. WOOD,
14 Federal St., Boston, Mass.
MONROE BRASS & WIRE CO.,
Cincinnati, Ohio.

ELECTRIC SERVICE SUPPLIES CO.,
50 Church St., New York, N. Y.
ELECTRIC SERVICE SUPPLIES CO..
17th and Cambria Sts., Philadelphia, Pa.
UNION ELECTRIC CO.,
933-935 Liberty Ave., Pittsburgh, Pa.

Canadian Representatives

LYMAN TUBE & SUPPLY CO., Montreal, Quebec; Toronto, Ontario.

Represented by the Westinghouse Elec. & Mfg. Co.

Butte, Mont.
Chicago, Ill.
Dallas, Tex.
Denver, Colo.
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El Paso, Tex.
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Salt Lake City, Utah
St. Louis, Mo.
San Francisco, Cal.
Los Angeles, Cal.
Seattle, Wash.

MANUFACTURERS OF

NUTTALL PRODUCTS FOR MINING MACHINERY.

"BP" Gearing

The high standard of reliability demanded of mine gearing is attained by "Nuttall BP" gearing.

"BP" Gears are guaranteed to give four times the life of untreated gearing in identical service; ultimate strength which will prevent breakage in service under the most severe conditions.

We are in position to furnish "BP" gears and pinions for Westinghouse, General Electric, Jeffrey and other locomotives; special types of mining machines and special equipment up to 84" in diameter.

The cuts at the left show sections of treated and untreated gear teeth; figure 1 shows the coarse granular structure of the untreated tooth, while figure 2 shows the contrast obtained by treatment, being very refined throughout.

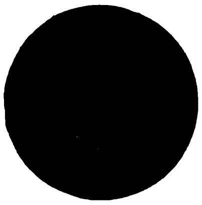


Fig. 1.

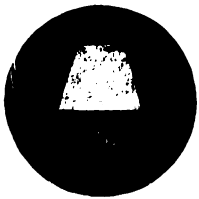


Fig. 2.

We are also the largest manufacturers of diversified gearing in the world and are equipped to manufacture gears to meet every requirement.

Grade	Relative Service	Relative First Cost		Cost of Cast Steel for Equal Life		Saving in Ultimate Cost	
C. S.	100%	100%	$30.00	100%	$ 30.00		
B. P.	400%	130%	39.00	400%	120.00	$81.00	67%

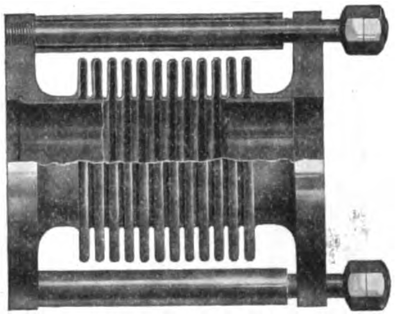
Nuttall One Piece Expasion Joint

This joint is the most lasting solution of Pipe Line Expansion difficulties.

It is accurately machined in one piece from a solid, hammer-forged steel blank then oil treated.

This construction eliminates the packing necessary in other types, and its great strength together with an arrangement of limiting bolts equipped with sleeves safeguards against breakage. Internal strain is cared for by a sliding sleeve on the inside.

The Joint is made to accommodate high and low pressure lines, allowing a total movement of 2" and ⅝", respectively. In actual test a Nuttall Joint proved 50 times more durable than ordinary expansion ojints.

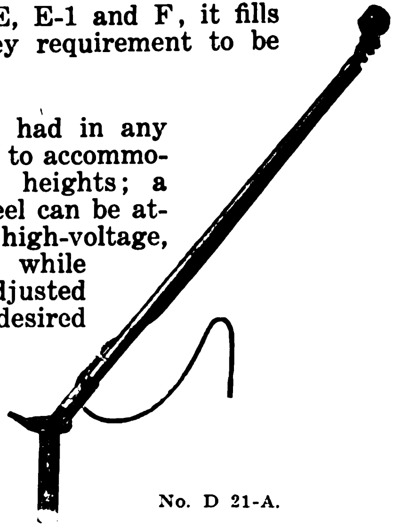

Cross Sectional View.

Mine Trolleys

The Nuttall D-21 Mine Trolley is the last word in efficiency, having seven different variations of form, A, B, C, D, E, E-1 and F, it fills every type of trolley requirement to be met with in mining.

The pole can be had in any length up to 10 feet, to accommodate various entry heights; a 6 inch harp and wheel can be attached to care for high-voltage, heavy-duty service, while the spring can be adjusted to furnish any desired wheel pressure.

This trolley has given such excellent service that it has been adopted as standard by both the Westinghouse and the General Electric Company and is used on their equipment.


No. D 21-A.

THE TOOL STEEL GEAR & PINION CO.

CINCINNATI, OHIO

Huntington Supply & Equipment Co.
Huntington,
W. Va.

J. P. Biggert,
Oliver Building,
Pittsburgh.

National Railway Appliance Co.,
New York
Chicago

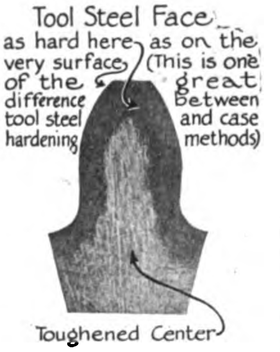
Products

"Tool Steel" Gears and Pinions for mining locomotives and machinery.

Gears and pinions constitute a considerable item in maintenance expense of coal mining equipment, both from direct costs and the costs and time lost in making replacements. Realizing this, The Tool Steel Gear and Pinion Company is now offering for coal mining equipment the same specially hardened gear and pinion which it has been selling to electric railway companies for the last nine years. A number of the larger coal mining companies have already adopted "Tool Steel" gears as standard in their replacements.

The "Tool Steel" wearing face takes on a brilliant polish and virtually eliminates friction.

The toughened center withstands all shocks and strains in severe service.

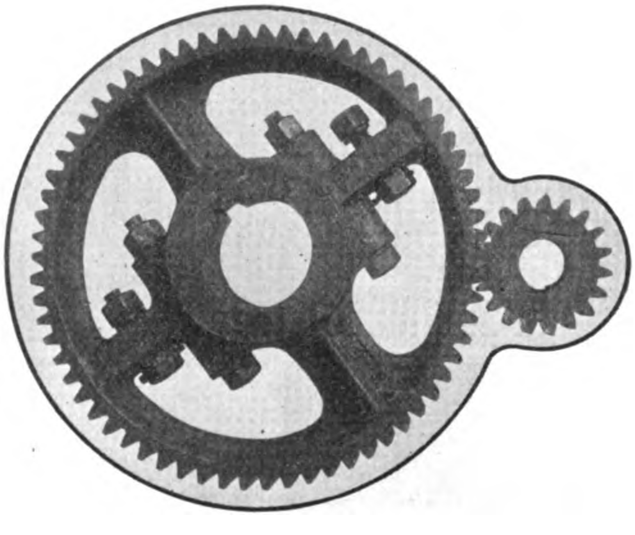

Tool Steel Face
as hard here as on the very surface
(This is one of the great difference between tool steel hardening and case methods)
Toughened Center

Increased Life of "Tool Steel" Gears

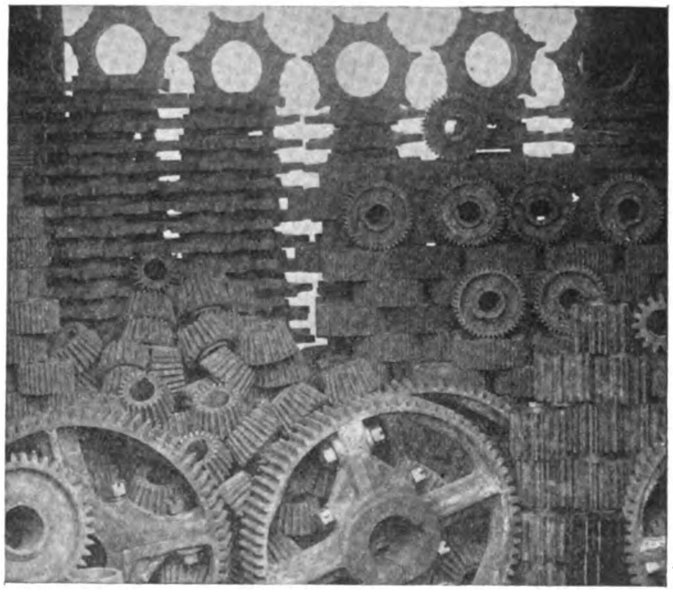
In repeated tests in the electric railway and coal mining industries, "Tool Steel" gears have given life from four to seven times as great as that averaged from ordinary untreated steel, from three to six times as great as that of oil treated steel and from two to four times as great as case hardened material.

Guarantee

Try a Tool Steel gear or a Tool Steel pinion, if it does not give sufficient life to entirely satisfy you send it back when worn out and we will refund the purchase price.



The photograph above is of a "Tool Steel" motor gear and pinion after 2½ years' use. In this particular service the average life of the untreated pinion was only six months.



This illustrates some of the classes of coal mining gears we are furnishing in quantities

BULLETINS AND QUOTATIONS FURNISHED ON REQUEST.

AMERICAN ABRASIVE METALS CO.

50 Church Street
NEW YORK CITY, U. S. A.

Manufacturers of

FERALUN
Brake Shoes and Anti-Slip Step Treads

Product

The Feralun Brake Shoe (Patented) is very similar to the regular brake shoe but having embedded in its wearing surface irregular pieces of emery.

"FERALUN" Brake Shoe

These are placed along the outside portion of the shoe face, and in the groove made for the wheel flange. Its purpose is to keep the wheels true by cutting down false flanges and by keeping the surface flat.

The Value of Feralun Brake Shoes

They

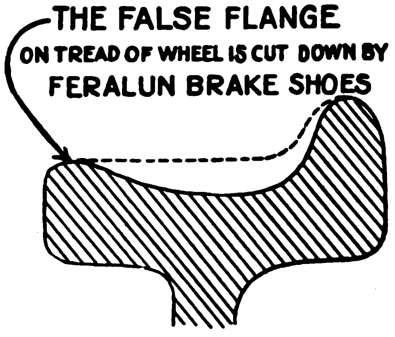
1. Assure longer life of the driving wheels;
2. Cut down false flanges;
3. Increase braking efficiency;
4. Keep motor in service;
5. Reduce wear and tear on power and track.

The Saving By Feralun Brake Shoes

They save the expense of

1. Taking off the wheels;
2. Turning or grinding wheels down;
3. Replacing wheels;
4. Loss of use of motor;
5. Wear and tear on power and track.

The wear on the wheels is not increased, but is adjusted to keep the wheel free from false flanges, for as soon as the false flange opposite the abrasive is reduced, the abrading action substantially ceases, and the wear on the wheel is then only what it would be with an ordinary brake shoe.



While the motor is in service AND AVOIDS TURNING OR GRINDING TIRES.

The following are extracts from a few of many testimonials:

BESSEMER COAL & COKE CO.:

"They have proven so far superior to the shoes previously used, that we will, if the opportunity presents, most heartily recommend Feralun to any of our friends having occasion to use motor brake shoes."

WASHINGTON COAL & COKE CO.:

"We are using your brake shoes on our motors and they are giving excellent service."

COLEMAN MINING CO.:

"The shoes are giving us first class service and we have NEVER HAD A SET OF WHEELS TURNED UP since we used Feralun Brake Shoes."

SUNFLOWER COAL CO.:

"They have given us entire satisfaction in service and have saved us at least 100 per cent. in cash."

Some Satisfied Users of Feralun Shoes

Allegheny River Mining Co.	Kittanning, Pa.
Bessemer Coal & Coke Co.	Pittsburgh, Pa.
Boomer Coal & Coke Co.	Boomer, W. Va.
Brothers Valley Coal Co.	Macdonaldton, Pa.
Cannelton Coal & Coke Co.	Cannelton, W. Va.
Carter Coal Co.	Johnson City, Tenn.
Christopher Coal Mining Co.	Christopher, Ill.
Colorado Fuel & Iron Co.	Denver, Colo.
Consolidation Coal Co.	Fairmont, W. Va.
Ford Collieries Co.	Curtisville, Pa.
Georges Creek Coal Co.	Lonaconing, Md.
Hutchinson Coal Co.	Fairmont, W. Va.
Jenner Quemahoning Coal Co.	Jerome, Pa.
Keystone Coal & Coke Co.	Greensburg, Pa.
La Follette Coal, I. & Ry. Co.	La Follette, Tenn.
Lehigh Valley Coal Co.	Wilkes-Barre, Pa.
Merchants Coal Co.	Pittsburgh, Pa.
Mt. Olive & Staunton Coal Co.	Staunton, Ill.
New Alexandria Coke Co.	Greensburg, Pa.
New Pittsburgh Coal Co.	MacDonald, W. Va.
New River & Pocah. C. Coal Co.	Charleston, W. Va.
North Jellico Coal Co.	Wilton, Ky.
Peale, Peacock & Kerr	St. Benedict, Pa.
Phila. & Reading Coal & Iron Co.	Pottsville, Pa.
Pitts. Terminal R. R. & Coal Co.	Pittsburgh, Pa.
Shawmut Mining Co.	Byrnedale, Pa.
Sterling Coal Co.	Bakerton, Pa.
Sunday Creek Co.	Columbus, Ohio
Superior Coal Co.	Chicago, Ill.
Susquehanna Coal Co.	Wilkes-Barre, Pa.
Tennessee Coal, I. & R. R. Co.	Birmingham, Ala.
Tunnell Coaling Co.	Greensburg, Pa.
Vandalia Coal Co.	Terre Haute, Ind.

Feralun Anti-Slip Treads

For stairs in breakers, tipples, etc. Will prevent slipping accidents.

The Alexander Car Replacer Mfg. Co.

SCRANTON, PA.

Products

Car Replacers, Wrecking Frogs.

Advantages

All mining men are well aware that derailments in the mine is one of the most frequent causes of delay. A locomotive or a car off the track ties up the whole transportation system, as well as the Tipple or Breaker.

Figure up for yourself the loss of tonnage and the cost resulting in such a tie-up.

It is quite obvious that the quicker you get the derailed locomotive or car back on the track the less will be your loss of time and money. With the Alexander Car Replacer these delays can be minimized. Derailments can be gotten back on the track in a very short time.

Each locomotive you have should be equipped with a pair of our car replacers, or in the case of a rope haulage system, a pair should be placed easy of access along plane or runway.

Sizes We Manufacture

No. 1 REPLACER—Weight 164 lbs. per pair; used on rail 5 to 6 inches high.

No. 2 REPLACER—Weight 158 lbs. per pair; used on rail 4 to 5½ inches high.

No. 3 REPLACER—Made of ⅜-inch steel plate for Electric Motors, Mine Engines, Electric Cars, and light equipment.

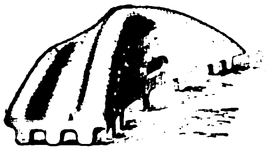
No. 1 EXTRA HEAVY—Made of ¾-inch plate, weight 212 lbs. per pair; same rail as standard No. 1.

Our Number Three Replacer is the size we sell to the mines for use inside the mine, while the other sizes are sold for use in the yard and sidings and for standard R. R. service.

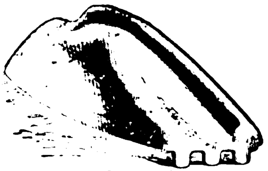
Material

Our No. 3 Replacers are made from 6-16 inch pressed steel. They have strength without weight. Quality, not quantity. This is the reason we make the Alexander Replacer of Steel Plate instead of cast metal. The illustration shown herewith will give you an idea of how easily they are handled.

There are now over seventy-five thousand pair of Alexander Replacers in use. Practically every railroad in the United States and Canada are equipped with them. Below we give a few letters and a partial list of mining companies who have equipped their mines with the Alexander Replacer.



INSIDE REPLACER.
Fig. 436 C



OUTSIDE REPLACER.
Fig. 437 C

Scranton, Pa., April 6th, 1912.

We use the "Alexander Replacers," inside and outside of our collieries, and find them very satisfactory—a money-saver in getting our daily output.

THOS. J. WILLIAMS,
Div. Supt. D., L. & W. Coal Dep't.

THE DELAWARE & HUDSON COMPANY.
Office of Superintendent Coal Department.
Scranton, Pa., Oct. 26th, 1910.

The Alexander Car Replacer Mfg. Co.,
Scranton, Pa.:

Dear Sir—In reply to yours of the 24th inst. wish to state that we have nearly one hundred of the No. 3 Alexander Car Replacers distributed about our collieries for replacing mine locomotives as well as cars on rope haulage. I find them almost indispensible, and it gives me pleasure to recommend them. Yours respectfully,

C. C. ROSE, Superintendent.

THE DELAWARE, LACKAWANNA & WESTERN RAILROAD CO.
Coal Mining Department.
Scranton, Pa., Oct. 17th, 1910.

The Alexander Car Replacer Mfg. Co.,

Gentlemen—I am in receipt of your letter of the 15th inst. asking for information as to the service rendered on inside work of the Car Replacer purchased from your Company.

We have in service in our different collieries about 160 pairs of your size No. 3, and I can only say that I have heard the best reports of their service, and we are now equipping all of our Electric Motors with this size Replacer.

Yours truly,
R. A. PHILLIPS, General Superintendent.

SOME OF OUR USERS AMONG MINING COMPANIES

Allegheny Ore & Iron Co.
Cambria Steel Co.
Colorado Fuel & Iron Co.
Consolidation Coal Co.
Delaware & Hudson Co.
D., L. & W. Coal Co.
Ellsworth Coal Co.
Fairmont Coal Co.
H. C. Frick Coke Co.
Hillside Coal & Iron Co.
Kingston Coal Co.
LaBelle Iron Co.
Lackawanna Iron & Steel Co.
Lehigh Coal & Navigation Co.
Lehigh Valley Coal Co.
Lehigh & Wilkes-Barre Coal Co.
Loup Creek Colliery Co.
G. B. Markle & Co.
Mineral R. R. & Mining Co.
New River & Pocahontas Coal Co.
New River Collieries Co.
Nova Scotia Steel Co.
Oliver Iron & Mining Co.
Pancoast Coal Co.
Pardee & Co.
Parish Coal Co.
Pennsylvania Coal Co.
Philadelphia & Reading Coal & Iron Co.
Piney Coal & Coke Co.
Rochester & Pittsburgh Coal & Iron Co.
St. Clair Coal Co.
Semet Solvay Co.
Sterrick Creek Coal Co.
Summit Branch Mining Co.
Temple Iron Co.
Tennessee Coal & Iron Co.
Thomas Iron Co.
Vesta Coal Co.
Virginia Coal & Iron Co.
West End Coal Co.
Wheeling Steel & Iron Co.
Wisconsin Steel Co.
and many others.

INDIANA FOUNDRY COMPANY

INDIANA, PA.

Sutton Sand Drying Stoves

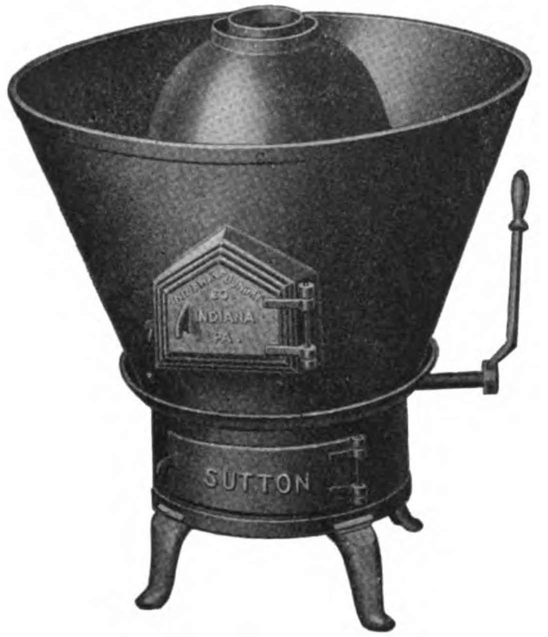
Products

Sand Dryers, Plain Heating Stoves, Etc.

Sutton Sand Drying Stove

The complete sand dryer made in 3 sizes.

Simple in design, very massive, and will stand the hardest usage. May be fed with hard or soft coal, coke or wood.



No. 1 weighs nearly 1,200 pounds. Capacity under ordinary conditions about 10 tons daily.

No. 2 weighs nearly 700 pounds. Capacity under ordinary conditions about 5 tons daily.

No. 3 is two-thirds the size and capacity of No. 2.

DIMENSIONS

Extreme height of Sand Dryers..	inches	58	49½	48¾
Height from base to top.........	"	48	40	38¼
Height of legs.................	"	10	10	10
Size of Firedoor................	"	10 x 12	10 x 12	11 x 11
Inside diameter	"	23	17	15
Grate diameter..................	"	22	15	12½
Skirting at top, diameter........	"	52	40	39
Distance from insider fire door to back of stove................	"	33	27	23¼
Thickness of castings...........	"	1¼	⅞	¾
Skirting capacity, cubic feet of sand		18½	8½	7½

Service

When the United States Government decided to buy Sand Dryers for the Panama Canal, the engineers in charge prepared a series of exhaustive tests of several makes and after thorough investigation and demonstration, adopted the SUTTON.

The government experts also made a careful analysis of the iron in order to secure the best fire-resisting castings.

What Does This Mean to You?

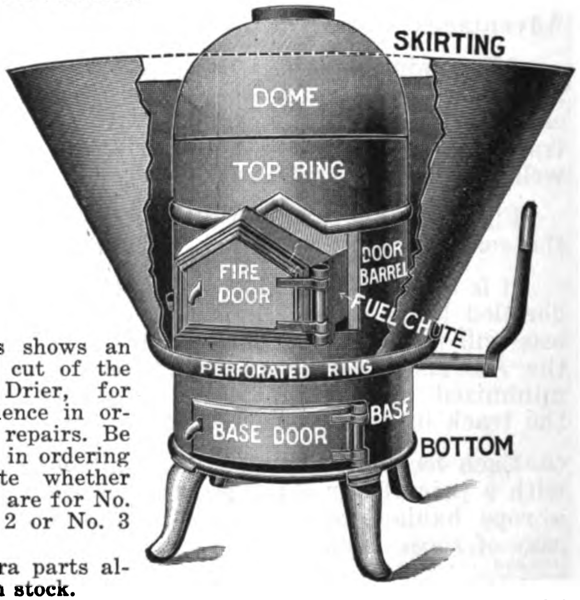
And what does it signify to you that the Sutton Sand Dryer is used in all the Government Navy Yards?

There is no Sand Dryer that does the work as economically and thoroughly as the Sutton.

Over two hundred Steam Railways, ranging in size and importance from the Pennsylvania Railroad and New York Central Systems to small lines having but one or two locomotives, use the Sutton Sand Dryer.

More than one thousand Sutton Sand Dryers are used in the Collieries of Pennsylvania alone.

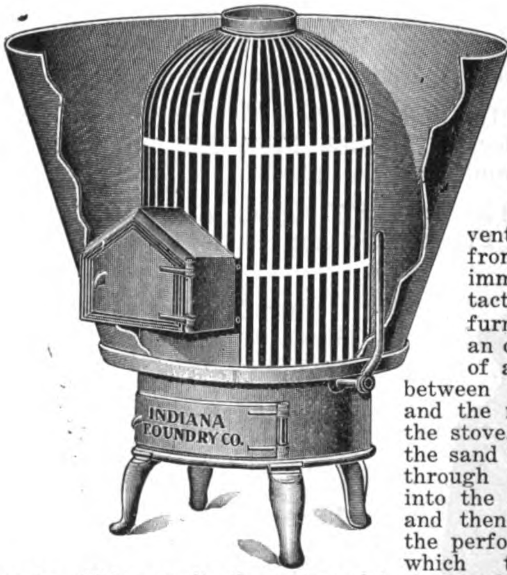
We guarantee the Sutton Sand Dryer to give satisfaction under all circumstances when used for the purpose for which it is intended.



This shows an outline cut of the Sand Drier, for convenience in ordering repairs. Be careful in ordering to state whether repairs are for No. 1, No. 2 or No. 3 stove.

Extra parts always in stock.

Always have a good fire in the stove before the sand is put in. Otherwise, the sand may bake and not discharge itself.


INDIANA FOUNDRY CO.

This cut represents the Upright Cast Iron Grating with which we surround the main body of our Sand Drier to prevent the wet sand from coming into immediate contact with the hot furnace. There is an open air space of about 1½ ins. between the grating and the main body of the stove. As soon as the sand is dry it runs through this grating into the hot air space and then out through the perforated ring on which the skirting rests. This permits the wet sand to dry much more rapidly than when it comes into immediate contact with the hot stove. Gratings prolong the life of the castings and are economical on fuel. Some of our customers claim that it fully doubles the amount of sand that can be dried in the same length of time.

Gratings are not furnished with the Sand Stoves unless ordered.

Plain Heating Stoves

We make several types of Plain Heating Stoves, in all capacities suitable for store, shop, etc., where heating is required.

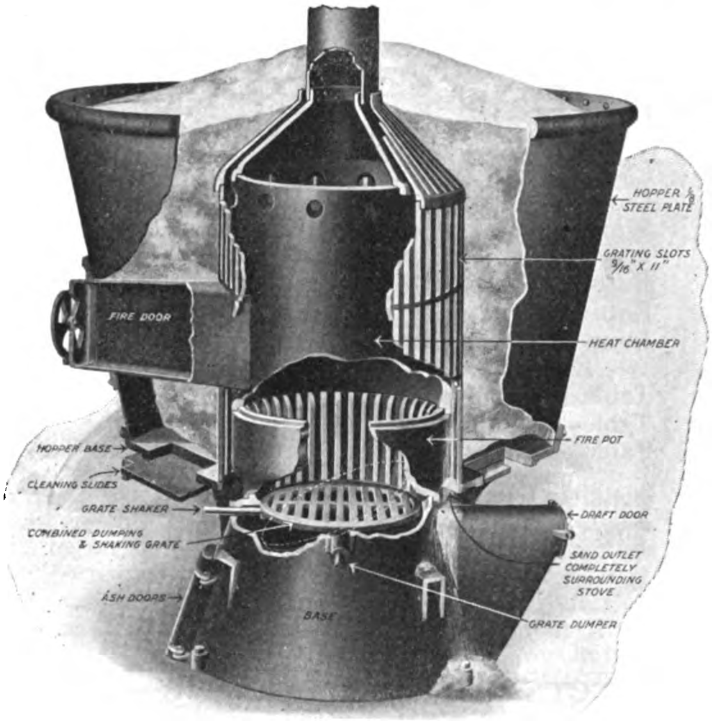
HARRY VISSERING & COMPANY

1616 LYTTON BLDG., CHICAGO

Manufacturers of

The "Viloco" Automatic Sand Dryer

The "Viloco" Dryer is **positively automatic.** Note the cast iron grating between body of sand and the stove, through which grating the **sand runs freely as fast as it dries.** This arrangement prevents wet sand coming in contact with stove and allows the moisture and vapor to escape between grating and stove into stack through holes at the top of the heat chamber.



As sand does not come in contact with stove, all possible burning out of stove is removed. Ample cleaning slides are provided around the entire hopper base to facilitate ready removal of any material that will not pass through the cast iron grating.

The grate is a combined shaking and dumping arrangement. Grate can be replaced through the large ash doors, thereby making it unnecessary to dismantle the dryer in order to renew the grate.

A man having other duties can easily attend to this appartaus. Saves initial cost first year in labor.

We have reduced repair expenses to a minimum. Any number in service two years without repairs.

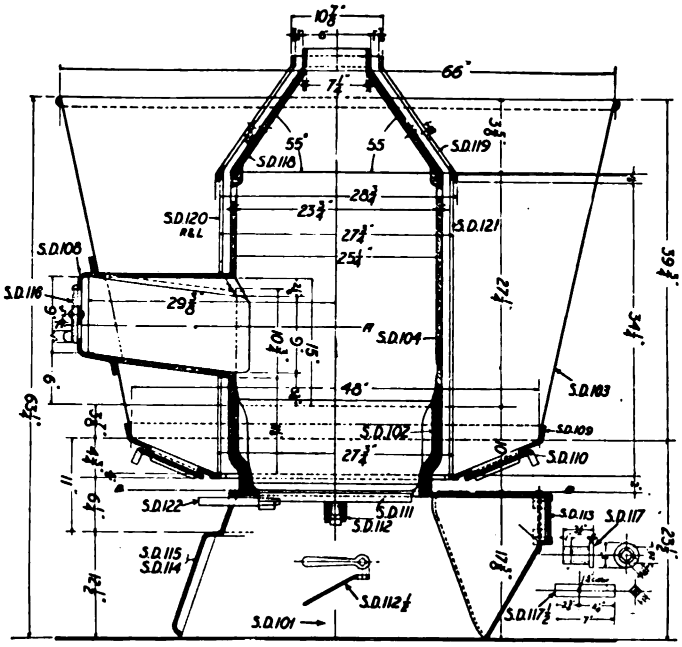
We will name scores of electric railways, railroads and coal mines in every section of North America, each and every one an enthusiastic satisfied customer.

Sand dryers, as usually constructed, consist of a stove surrounded by hopper of wire netting. the sand coming in contact with the stove dries first and has no means of escape until all of the sand within the hopper is sufficiently dry to start running through the wire netting forming the hopper. In the meantime, sand lying in contact with the stove becomes sufficiently hot to be thoroughly burned and materially assists in burning out the stove itself. Sand which has been burned loses its value and usefulness.

Our "Viloco" Dryer works on the principle that as soon as the sand is dry, it is free to escape. It does not burn the sand.

Names of Parts

S. D. 101.	Base
S. D. 102.	Fire Pot
S. D. 103.	Hopper
S. D. 104.	Heat Chamber
S. D. 108.	Fire Door
S. D. 109.	Hopper Base
S. D. 110.	Cleaning Slides
S. D. 111.	Grate.
S. D. 112.	Grate Support
S. D. 112½.	Wrench
S. D. 113.	Draft Door
S. D. 114.	Ash Door
S. D. 115.	Ash Door
S. D. 116.	Fire Door Damper
S. D. 117.	Grate Support Bushing
S. D. 117½.	Grate Support Pin
S. D. 118.	Hear Chamber Top
S. D. 119.	Top Grating
S. D. 120.	Grating, L.H.
S. D. 120.	Grating R.H.
S. D. 121.	Grating
S. D. 122.	Grate Shaker Bar



MINE DRAINAGE AND PUMPING MACHINERY SECTION

Treatise
and
Engineering Data

Specification Data for Pumps.
Table of Capacities of Pumps.
Selection of Proper size Motor for your pump.
Capacities of Single-Acting Triplex Pumps.
Friction Loss in Pounds Pressure.
Theoretical Horse Power required to raise water to different heights.
Table—Stroke for Piston Speed of 100 Feet Per Minute.
Table—Relative Qualities of Water Delivered in 24 Hours.
Friction of Water in Wrought and Cast Iron Pipes.
Friction of Standard Pipe Fittings.
Comparative Table of Pipe Capacities.
Cost of Pumping.
Water•Head in Feet and Equivalent Pressure in Pounds Per Square Inch.
Barometric Pressure.
Equivalents in Liquid Measures and Weights.
Input Horse Power Necessary at Various Efficiencies.
Table of Equivalent Pumps.
Table—Standard Sizes of Wrought Pipe.
Table—Standard Sizes of Wrought Welded Tubes.
Table of Equalizing Pipes.
Chart—Flow of Water Into Pipes.

The following manufacturers have catalogue descriptions in this section:

Aldrich Pump Co.
Allis-Chalmers Mfg. Co.
American Well Works, The.
American Steam Pump Co.
Byers, A. M., Co.
Cameron, A. S., Steam Pump Works.
Cast Iron Pipe Makers.
Concrete Products Co. of Pittsburgh.
Connellsville Mfg. & Mine Supply Co.
De Laval Steam Turbine Co.
Deming Co.
Dravo-Doyle Co.
DuBois Iron Works.
Eagle Pipe & Supply Co., Inc.
Harris Pump & Supply Co.
Elmore, G. H.
Epping-Carpenter Pump Co .
Fairmont Mining Machinery Co.
General Electric Co.
Goulds Mfg. Co.
Highland Chemical Products Co.
Leadite Co., The.
Luitweiler Pumping Engine Co.
Michigan Pipe Co.
Morris Machine Works.
Poole Engineering & Machine Co.
Platt Iron Works.
Pneumelectric Machine Co.
Reineke-Wagner Pump & Supply Co.
Rumsey Pump Co., Ltd.
Standard Wood Pipe Co.
Star Mfg. Co., The.
Swaby Mfg. Co.
Westinghouse Electric & Mfg. Co.

For additional descriptions of Hydraulic Equipment, not appearing in this section, refer to Index of Products in front of book.

MINE DRAINAGE AND PUMPING MACHINERY

By E. N. Zern, E. M.*

SOURCES OF MINE WATER.

Water enters into underground working principally by percolating through the pervious strata. It is estimated that nearly 80 per cent. of the rainfall in the eastern part of the United States, and 95 per cent. in the west, sinks into the ground and through the porous rocks, sands, and gravels beneath. The quantity met with in mines depends upon the depth and nature of the overlying formations. Drift openings usually have to contend with less water than shafts. Strata which are regular and of dense homogeneous material resist the passage of water, whereas measures which are faulted, creviced, or broken make the ingress of water easy. The tendency of water to follow lines of weakness is well illustrated in meeting with a clay vein. Water may be found issuing from these in large quantities, the loose adhesion between the clay rock and the penetrated strata providing the necessary channels.

The yearly rainfall of a region enters largely into the quantity of underground water. Thus, in many sections of Colorado, where dry and arid conditions obtain, pumping is not a serious problem, while, on the other hand, in the anthracite regions of Pennsylvania the inflow of water is very large. At some of the operations of the Pennsylvania Coal Company 7 tons of water are hoisted for each ton of coal; the Susquehanna Coal Company figures show 9.3 tons of water per ton of coal; the Philadelphia and Reading Coal & Iron Company, 12 tons; the Delaware and Hudson Company, 14.3 tons; and the Lehigh Valley Coal Company, 15 tons. The average for the entire anthracite region, as shown by the annual report of the Department of Mines in Pennsylvania, is 13.5 tons of water inflow for each ton of coal hoisted and this ratio will probably increase in years to come.

The time required for a protracted rain-fall to reach the workings depends on the thickness and character of the strata penetrated. In shallow mines, the effect of a rainy period is quickly noticeable. If the outcrop be pierced at many points, so much water may enter the mine as to flood the working places. In deeper mines the effect may not be observable until weeks have passed. Thus it was found at a large pumping station in the Connellsville region, where a monthly record of rainfall and the total number of gallons pumped was kept, that the pumping requirements were heaviest in the months immediately following the greatest precipitation. Inasmuch as the depth from the surface varied from 200 to 400 feet, the record would indicate that the penetrating waters required a month to travel this distance.‡

Frequently mines which are naturally dry, remain so only until the pillars are drawn and breaks are made reaching to the surface. This may release large quantities of water contained in the overlying strata; channels of surface springs may be broken and their contents diverted into the mine and wells and cisterns may be completely drained. Moreover, the rain-fall finds easy entrance through the fissures. Precautions should always be taken not to break the intervening strata directly under a water course or a standing body of water. If possible the water should be diverted, or, in the case of a standing body, drainage, or pumping to dryness, should be resorted to.

Water sometimes finds its way into the mine from adjoining abandoned workings by seeping underneath the barrier pillars. When such standing quantities are suddenly released by the accidental penetration of rooms or entries, the volume of water released may be sufficient to flood the mine and drown the workers, as was the case at the South Wellington Mine No. 1, near Nanaimo, B. C., where the firing of a shot in a dangerously small barrier pillar released a body of water sufficient to cause a loss of 20 lives.†

While underground workings will always contain more or less water, it is possible, by the exercise of proper precautions, to prevent much of the surface water from entering the mine. In shallow mines, where caves or sinkages have been formed on the hill sides, the water may be diverted by ditching around the top and sides of the cavity. A wise precaution is to have the discharge from all pumps at a proper distance from the shafts. Where the coal seam is reached by shafts in which the water is not sealed off, a considerable portion of the work of the pumps may consist of handling the water which comes down these openings. That it is possible to stop such a flow is well shown at the Jed mine (now called Havaco mine), near Welch, W. Va., where by means of a heavily reinforced concrete lining, with a special backing designed to resist the force of cement grout placed under pressure, both shafts were so succesfully sealed that the flow was cut down from about 600 gallons of water per minute to possibly a pint.§ Water rings are generally placed in wet timbered shafts and the water that collects in these may be pumped to the surface, rather than allowing it to gravitate to the bottom, there to add to the burden of the main pumps.

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*Head of Mining Department, West Virginia University.
‡Mines and Minerals, Vol. 29, pg. 248.
†Coal Age, Vol. 7, pg. 374.
§Coal Age, Vol. 7, pg. 2.

HISTORICAL DEVELOPMENT OF PUMPING.

At the beginning of the eighteenth century mechanical appliances began to be adopted at collieries. Hitherto water in buckets was raised out of pits by hand or horse gin, and in the shallow pits of Scotland carried up the ladders. Wherever available, water power was used to raise buckets attached to an endless chain, as in Fig. 1.

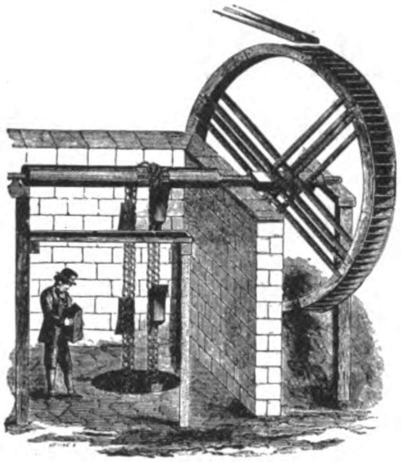

Fig. 1. Water Wheel and Bucket Pump†

In many instances a comparatively small amount of water was sufficient to stop the workings altogether. But this great difficulty was overcome by Newcomen's atmospheric engine, as it was called, which he patented in 1705, and which a few years later was applied to pumping water out of mines.* The engines grew to a gigantic size, with cylinders 60 inches in diameter and other parts in proportion. The pump was the simple bucket type, connected by means of a long rod to the walking-beam, E, of the engine. See Fig. 2.

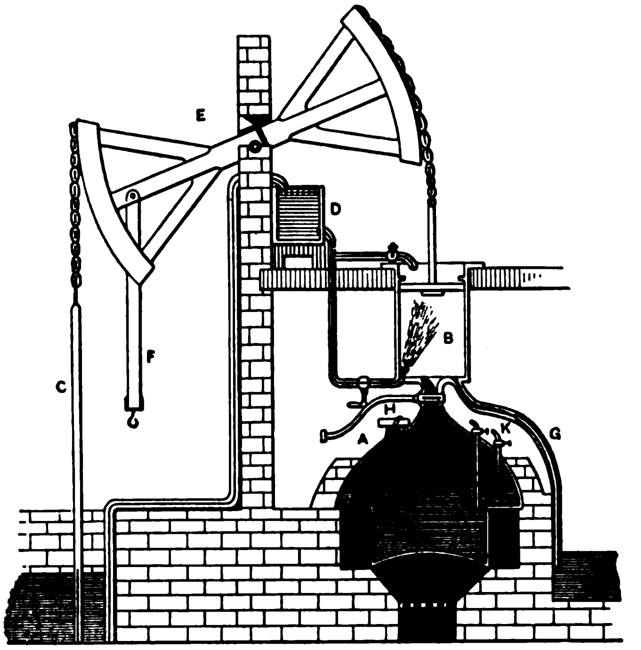

Fig. 2. Newcomen's Atmospheric Engine.

Steam slightly above atmospheric pressure was generated in the boiler, A, located beneath the steam cylinder, B. The weight of the pump rods, C, was almost counterbalanced, merely sufficient unbalanced weight remaining to raise the steam piston to the position shown in the figure when aided by the low steam pressure, which was admitted through a valve at the top of the boiler, filling the cylinder. With the closing of the valve, water from a reservoir, D, was sprayed into the steam space, thus condensing the steam and creating a vacuum. The air pressure on top was sufficient to force the piston down, thereby raising the pump rods at the other end of the walking-beam, and with it the plunger at the lower end. The condensed water was drained away from the cylinder through the pipe, G, into a hot well. In the figure, K, are the try cocks, and, H, is the safety valve. The early types required an attendant to open and close the valves. Newcomen's invention received its name from the fact that the effective stroke of the engine was due to the pressure of the atmosphere. By the year 1721 it was in general use for pumping and very materially aided the development of mining. In improved form, it remained standard for about a century when the introduction of Watt's steam engine took its place.

Watt early applied his invention to the unwatering of mines and this led to the development of the Cornish system of pumping. This consists of a vertical engine, located either at the side of, or over, the shaft and connected by means of long wooden rods, known as pump-rods, or spear rods, to the pump cylinders at the bottom of, or interspersed within, the shaft.

When placed directly over the shaft it is known as the Bull engine. The pump-rods form a continuous connection between the piston-rod and the pumps. See Fig. 3. This form of construction reduces the cost of machinery and its erection, but these advantages are offset by the excessive foundation required to guard against settlement around the shaft, the inaccessibility of the engine and the danger from fire in the shaft.

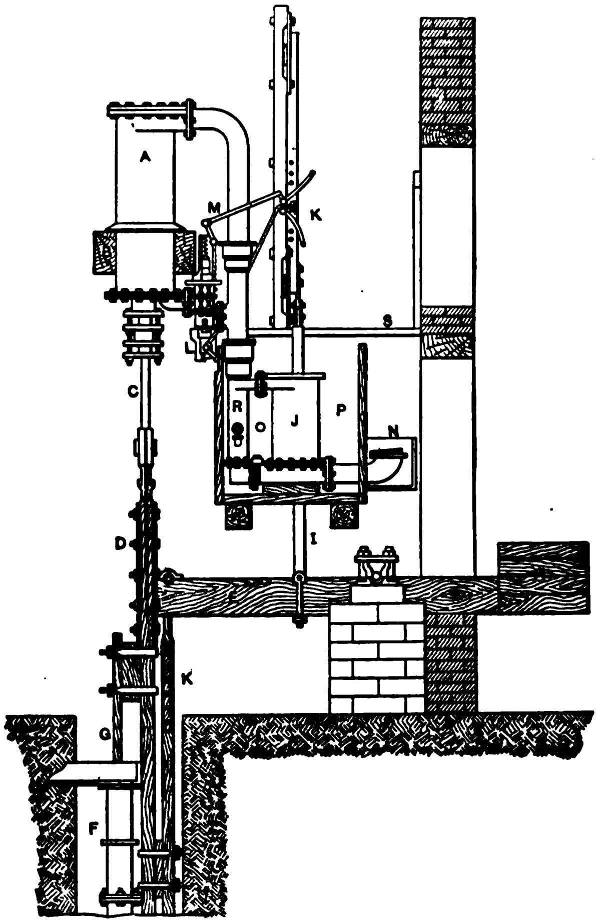

Fig. 3. Bull Engine.

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†Illustration from "Coal Pits and Pitmen," by Nelson Boyd.

*For a complete history of pumping appliances, see "Pumping Machinery," by A. M. Greene, Jr., from which volume Figures 2, 3 and 4 are taken.

The more common form of Cornish pump is where the engine is set at the side of the shaft. The piston rod is attached to one end of a walking-beam or "bob," and the pump rods to the other end. See Fig. 4. In its later forms, it may be described as a single-acting, high-pressure, expansive condensing engine operating a single-acting pump. In its working, steam is admitted at the top of the cylinder, thus forcing the piston to make its down stroke. This raises the rods. Steam is then cut off and an equilibrium valve opened by means of a tappet rod. This enables the steam to pass to the lower side of the piston, equalizing the pressure in both ends of the cylinder. The down stroke is effected by the weight of the rods alone. This forces the water up the delivery pipes. At this point the steam is exhausted into a condenser and a vacuum formed. At the same time steam is readmitted to the upper side of the piston and the cycle repeated. Between strokes there is a slight pause during which the valves have time to close, thus eliminating shock. This is accomplished by setting the fulcrum of the beam slightly off center so that the stroke of the engine is somewhat longer than that of the pump plunger.

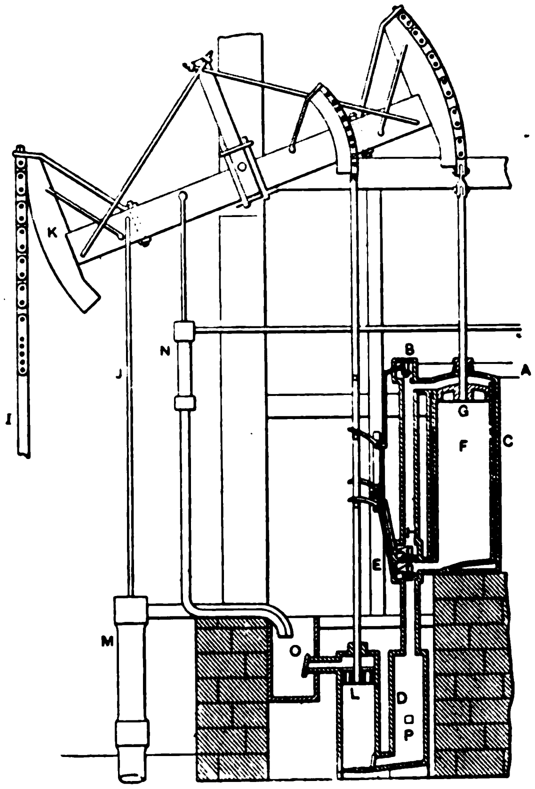

Fig. 4. Watt's Engine.

The pump rods are usually made of pitch pine, or oak, in 30 foot lengths, and square or rectangular in section. The common square joint, or else the scarf joint, is used for joining the rods. They vary in size from 4 inches to 12 inches, depending upon the length of the lift and the size and speed of the engine. As an instance of an excessive requirement it is stated that at the Maira shaft, 2300 feet deep, the upper 780 feet of the rod has a cross-section of 16″ by 32″. Vibration, twisting or buckling of the rods is prevented, or minimized, by collaring, or guides, which are placed at suitable intervals, and consist of stout frames which totally enclose the rods.

The bucket and plunger types of pumps are both used for raising the water. When the former is used the water is lifted on the up-stroke of the rods. Since this materially increases the work of the engine, it is customary to counter-balance the weight of the rods with balance-bobs. With the plunger type, the water is raised on the down stroke of the rods, thereby dividing the work more equally. With engines of the Cornish type, the lift is generally less than 300 feet, and when shafts exceed this in depth it becomes necessary to pump in stages. Under these conditions, it is usual to have the bottom one a bucket pump and all of the others plunger pumps. The lower pump, being of the bucket type, permits the rod to be drawn out at the top should trouble be experienced in time of flooding.

The Cornish system, as a whole, is massive, runs at slow speed and is expensive in first cost and installation. Long usage under mining conditions, however, has proven that when properly installed it gives little trouble and is very reliable.

In all of the pumping appliances up to the year 1840, the power generating unit was on the surface and the pump proper underground. About this time there was developed in America the direct-acting steam pump in which the steam and the water cylinders are brought close together in a direct line and their respective pistons rigidly connected by means of a continuous rod. This marked a radical departure from the prevailing mechanisms and to Henry R. Worthington is due much of the credit for the rapid development attained. The direct-acting duplex steam pump followed several years later as a result of his efforts to remedy the intermittent action of the simplex pump and in his search for a more efficient valve motion.

The compactness of this new type of pump, along with the ease with which it may be erected, or removed to other parts of the mine, brought it into instant favor. Its disadvantages proved to be the large condensation and heat losses in bringing the steam from the surface, sometimes at a great distance; the oppressive and dangerous heat of the pipes, and the difficulty in disposing of the exhaust steam. Added to this was the difficulty in using steam economically.

The search to eliminate these drawbacks led to the introduction, in the early 90's, of a new design known as power pumps and driven by an electric motor. The increased efficiency of this pump, along with the growing use of electricity underground, has made this type of pump a fixture in mining practice.

The centrifugal pump may be said to be a development within the present decade, though experimental pumps embodying the turbine principle were constructed in this country as early as the year 1818. The single-stage single-suction pump was the first attempted and was cosidered satisfactory for handling large quantities to a heighth not exceeding 20 feet. Further experimenting led to the development of the multi-stage pumps for handling water against high heads, many of which are now installed in mines and giving efficient and satisfactory service.

The types of pumps which are in present day service will be discussed later under their respective heads.

GRAVITY METHODS OF DRAINAGE.

The Siphon

Because of its simplicity, low cost of installation, and economy of operation, the siphon is extensively used in mining. It may be described as a pipe of varying length, bent upward at some point forming two legs, one of which is for suction and the other for discharge. The ends of both lines are submerged to prevent the entrance of air into the pipe and reaching the summit of the siphon.

The siphon is started by closing the valves placed at each end of the line and filling the pipe with water through an opening at the summit. If pumps are close by, a small pipe may be led from their discharge to the siphon and used for filling. A method in common use is to fill the line with a small hand force pump. When filled, flow is started by opening both valves.

The purpose of the siphon is to raise water from a basin or depression, over a summit to a sump having a lower elevation than the source of supply. The flow of water in the suction end is induced by atmospheric pressure, working in opposition to the force of gravity. The difference in elevation between the surface of the water and the summit, or h, in Fig. 5 can never be greater than the heighth of a column of water supported by atmospheric pressure. At sea level, under normal conditions, this is about 34 feet. However, since the suction end of the siphon acts in all respects like that of a pump, having frictional and valve resistances, the vertical lift of the siphon in feet should not exceed 60 per cent. of the heighth of the water column supported by atmospheric pressure, or in terms of the mercurial barometer, .7 of the pressure shown in inches. Even this may prove an excessive allowance where the suction line is long.

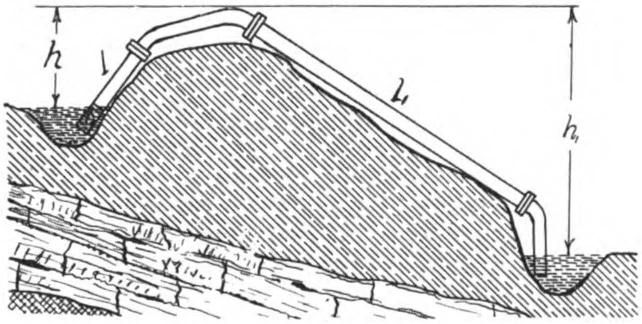

Fig. 5. The Siphon.

The flow of water in the discharge pipe is induced by gravity acting in opposition to atmospheric pressure. Hence we have in the siphon two different motive powers, and these, it will be found, are capable of producing dissimilar flows in their respective ends. A siphon will operate to the best advantage and give maximum results for the diameter of pipe used, when the flow in the discharge end is equal to that in the suction end. If the discharge exceeds the suction, flow of water will cease owing to the outflow exceeding the inflow and the siphon tending to empty itself. The remedy in this case is to use a larger pipe on the suction side, or a smaller pipe on the discharge side, or preferably, where the siphon is once installed, to throttle the discharge by means of a valve, thus tending to equalize the flow on both sides of the summit. If the suction flow exceeds the discharge, the siphon will continue in operation, though the quantity of water emitted will be lessened.

The foregoing are important facts in the operation of a siphon and the failure to properly understand their significance has lead to frequent failure in its use. Assuming elevation at sea-level, the relations between the dimensions of suction and discharge ends, in order that the operation of the siphon may be free from throttling devices is,

$$\frac{(34\text{-}h)d^5}{l} = \frac{(h_1\text{-}34)d_1^5}{l_1}$$

when h and h_1=head in feet causing flow in suction and discharge end.
l and l_1=length of pipe in feet on suction and discharge end.
d and d_1=diameter of pipe in inches on suction and discharge end.

The discharge of the siphon in gallons per minute may then be calculated by the formula—

$$G=2.83\ d^2 \sqrt{\frac{d\ (h_1\text{-}h)}{f\ (l_1+l)}}$$

In this formula, f, is a coefficient of friction which may be taken is .01; d is the diameter common to both suction and discharge ends.

Ditches

In drift openings, where the seam rises into the hill, it is possible to effect entire drainage by means of ditching, openings being made to the outcrop whenever advantageous. When these water courses are once established, the cost of drainage consists of merely the maintenance and an occasional cleaning. The cost of construction will depend upon the length and depth of the ditch and the hardness of the bottom.

Contours of the floor, at one foot intervals, where the undulations are not great, will be of great assistance in determining the direction and depth of ditches. These contours are placed on the mine map, the levels being taken by the engineering corps at the time of their usual posting survey. With this information at hand, together with a knowledge of the hardness of the underlying formations, an intelligent opinion can be formed as to the most direct course to follow and the advisability of resorting to ditches in place of auxiliary pumps.

As illustrating the use of ditches in drainage, the Redstone pumping station, near Uniontown, Pa., may be mentioned.‡ The installation consists of four 3000 gallons-per-minute units discharging through a 16 inch bore hole against a head of 350 feet. By an extensive system of ditching, leading to a large sump close by the pumps, the water is gathered from three mines belonging to the H. C. Frick Coke Company, each of which, before the installation of the central pumping station, had its individual pumping system. Inasmuch as the ratio of water hoist to coal is at times 25 to .1, the economy effected by using ditches to centralize the work of the pumps is evident.

The gradient used in ditches will be governed largely by local conditions, such as the difference in elevation between points, the length of the ditch and the difficulties in excavation. A gutter at the side of the track with a slope of 1 in 500 readily carries off the water provided it is kept clear of refuse, though it is more usual in mining practice to find this grade exceeded.

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*Coal Miners Pocketbook, pg. 352.
‡Proceedings Coal Mining Institute of America, 1911, pg. 227.

Drainage Tunnels

A point is sometimes reached in mining enterprises where the cost of raising water to the surface is so burdensome as to make the enterprise unprofitable. Under such conditions, the working of lower deposits is out of the question, for the deeper the workings lie, the greater is the head to be pumped against and the greater the cost. Again, during the rainy season, when the pumping requirements may be trebly that of the normal periods, the mine may be drowned out unless spare units, sufficient to cope with an emergency, are carried. This requires a large amount of capital to be tied up in the outlay of pumping machinery, boilers, pump-houses, etc., in such a way as to make it unproductive.

When by the expenses of pumping, profits are reduced to the vanishing point, either mining must cease, or recourse be had to a less expensive method of unwatering. The drainage tunnel, starting usually near some water-way, and penetrating the country at a level below that of the workings to be drained, is a device which has proven the savior of many a mining enterprise. Even where the workings are mainly below the general level of the country, adits may still be effective inasmuch as they drain the upper sections by gravity, and reduce the height to which the water from the lower portions has to be pumped. Since the cost of tunnels is great, the decision in their favor as compared to pumping, will be governed by amortization and the interest rate on the amount invested on the one hand, as balanced against interest, depreciation, labor, fuel and maintenance on the other. Because of the high initial cost of tunnels, in some localities the drainage of the district is accomplished by a co-operative scheme with very beneficial results.

Some of the longest and costliest adits have been driven in the metalliferous districts of Europe. One of the most celebrated is the "Rothschonberger Stolln" which unwaters some of the most important mines at Freiburg in Saxony.* The length of the main, or trunk, adit is more than 2½ miles; the gradient of the greater part of it is only 1.18 inches in 100 yards. Branches of this adit traversing the mines are more than 16 miles in length, so that the total length of the main tunnel with its ramifications amounts to about 25 miles. The cost of the main tunnel was approximately $1,750,000 and the time occupied in driving thirty-three years.

The Halkyn tunnel in Flintshire, England, although but 4 miles in length is remarkable for the quantity of water discharged, it being estimated that 66,000 tons are delivered in 24 hours.

One of the earliest adits constructed in the United States is the Sutro tunnel, which enters the workings on the Comstock lode at a depth of 1700 feet from the surface. Work was begun in October, 1869, and the tunnel met the workings in July, 1878. The length of the main tunnel is 3⅞ miles and its cost up to October, 1881, was $2,096,566. The quantity of water running out daily in 1879 was 12,000 tons, at a temperature of 123 deg. F. when leaving the mouth of the tunnel. The use of this tunnel effected a saving of $3,000 per day.

Another example of the economy of adit drainage is the Roosevelt tunnel which has added 740 feet to the workable depth of the mines in the Cripple Creek district, and at an expenditure of less than $600,000 is accomplishing a work that would have required $10,000,000 to accomplish by pumping.

Leaving the metal mines, we find in the anthracite regions of Pennsylvania many interesting applications of tunnel drainage. Amongst these may be mentioned the two Oneida tunnels draining mines operated by the Lehigh Valley Coal Company. The first of these was driven in 1910 to a distance of 5600 feet and relieved five large mine pumps; the second tunnel, 7030 feet long, was driven in 1913 and released twenty large pumping units, one of which was lifting water 500 feet. The Lausanne tunnel, which drains the mines of the Lehigh Coal & Navigation Company into the Lehigh river, is 7500 feet in length to the point where it connects with the Buck Mountain drainage gangway. By a series of passages, 13 miles long, 14 collieries in the Panther Creek basin, between Mauch Chunk and Tamaqua, are drained. This tunnel, which required six years to build, will carry all the water from a large territory yet to be worked, while the pumping lift from the lower workings will be materially reduced. The grade of the tunnel is ¼ of 1 per cent. Its area of section is 94.3 square feet and the cost was estimated to be $700,000, with an estimated yearly saving of about $150,000.†

One of the best examples of the expediency of tunnels is furnished by the Georges Creek region in Maryland where a territory containing some 10,000 acres of Big Vein (Pittsburg) coal, belonging to the Consolidation Coal Company, is successfully drained by a system comprising 3.7 miles of rock tunnel and 14.6 miles of rock ditching. The estimated flow of water from the three tunnels during the rainy season of 1912 was fully 50,000 gallons per minute, or approximately 300,000 tons per day. This is equal to more than 35 tons of water for every ton of coal mined.‡

Mine Dams

Not only is it advisable to use all means to prevent access of water from the surface, but, furthermore, it is good policy to cut off underground flows as far as practicable. As in the case of an extremely wet shaft, where sealing off the water may be done by means of concrete and grout, so is it equally feasible to seal off the inflow from sections of the mine by the use of a dam. This may be defined as an artificial stopping placed in a passage for the purpose of preventing the inflow of water coming from an adjoining abandoned working, or from some particularly wet strata.

Dams are constructed of timber, brick, stone or concrete. The wooden dam has had high favor on the Continent of Europe, while in England and America masonry is generally employed. Wooden dams are built of dry sticks of timber laid horizontally and well wedged. Pine and fir are the woods preferred. When wet, the wooden dam has the advantage of swelling, thus tending to make the construction water-tight. In addition, there is no danger of cracks or breaks when under pressure, as may be the case in masonry dams. The masonry, or concrete construction, however, is the one generally used.

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*A Text-book of Ore and Stone Mining, C. Le Neve Foster.

†Mines and Minerals, Vol. 28, pg. 163.

‡Proceedings West Virginia Coal Mining Institute, 1912, pg. 152.

The first requirement in dam building is to find a suitable place, free from cracks or crevices, whereby water might leak through from behind the dam. The walls should be solid and the top and bottom firm. Dams are usually shaped to represent the frustum of a square pyramid, with the broad end toward the pressure, which, in effect, drives the wedge and compresses the materials, thus adding to its effectiveness.

The frustum shape is brought about by cutting recesses into the top, sides and bottom, as shown in Fig. 6. This is done with the pick, without the aid of explosives for fear of fracturing the rock. The four sides are smoothly trimmed. Brick, or stone, if used, are laid up in cement mortar.

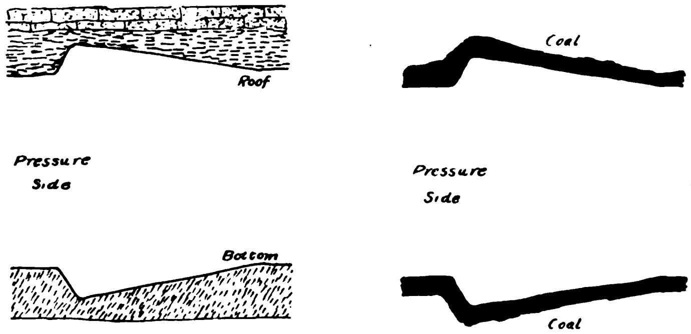

Fig. 6. Showing Cuts Made to Receive the Dam.

The brick dam used at Kehley's Run Colliery at Shenandoah, Pa., to isolate a portion of the seam so that it might be flooded to extinguish a mine fire, is shown in Fig. 7. It is composed of three brick arches, each having a thickness of five feet, placed one against the other so that they act as one solid structure. The back wall was made higher and deeper than the others to insure against slips which the other walls might not reach. The gangway was about twenty feet wide and the total pressure upon the dam was about 70,000 pounds per square foot.

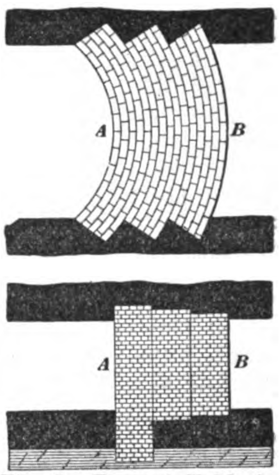

Fig. 7. Dam at Kehley's Run Colliery.*

The construction of a concrete dam to withstand a pressure of 200 pounds per square inch is shown in Fig. 8. The arch form is missing, straight forms being used on both front and rear to lessen the labor and material costs. For the reason that concrete might not prove water-tight under the high pressure intended, a three inch layer of water-proofing compound was placed against the pressure side and carried up with the concrete, thus insuring a good bond. As is usual in such constructions, drain pipes were placed near the bottom so that the accumulating waters could be passed away without hindrance to the workmen. Valves were placed on these and closed when the work was completed. A manway was provided consisting of an elliptical pipe closed at both ends by means of steel doors. This allowed inspections or repairs to be made, and particularly the renewing of the waterproofing in case of necessity. When the concreting approached the roof, seven 2-inch grout pipes were placed in the concrete, four on the pressure side and three on the opposite side. Grout was successively forced into the several pipes by means of air under a pressure of 85 pounds per square inch. The construction proved practically water-tight.

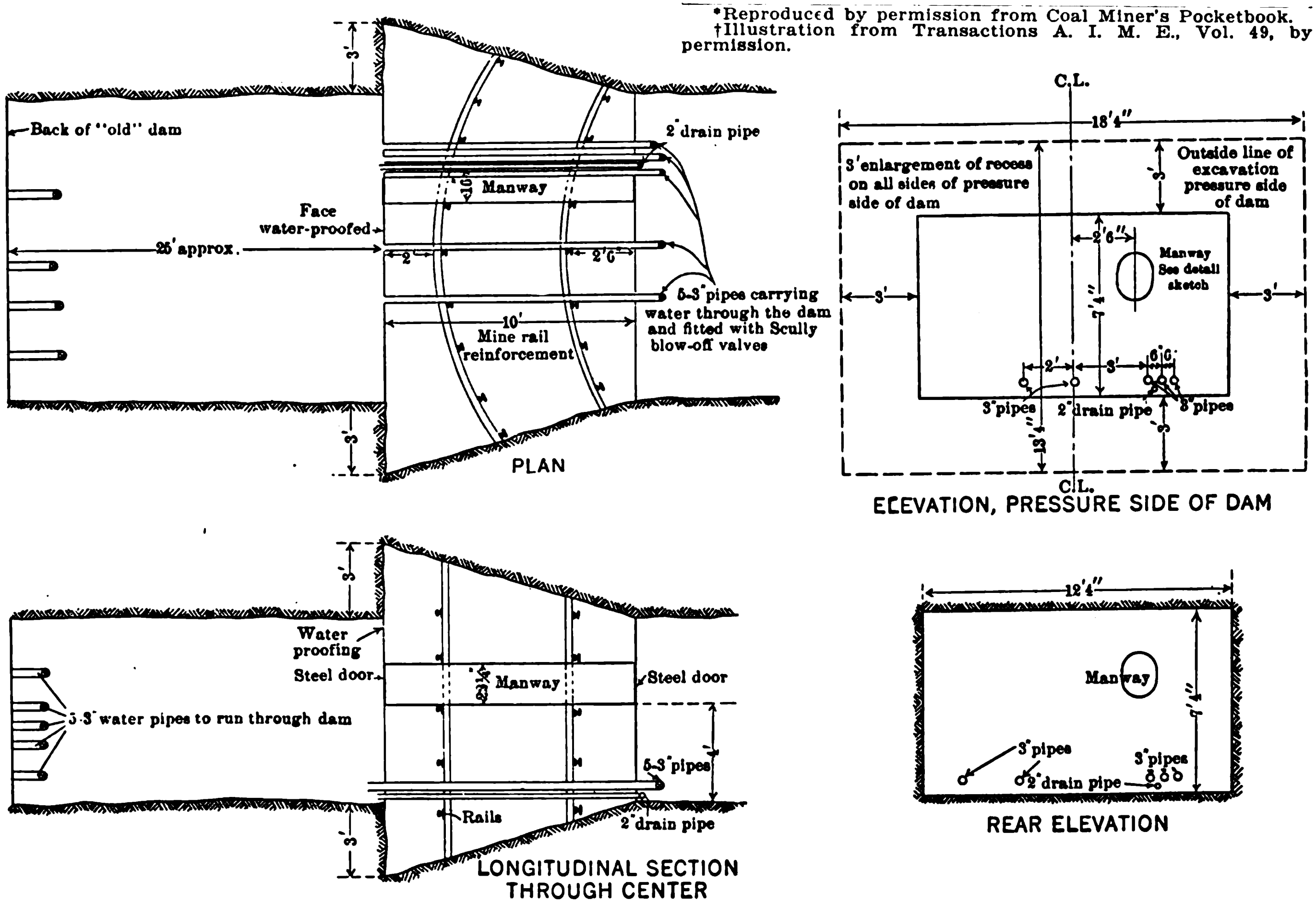

Fig. 8. Concrete Mine Dam.†

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*Reproduced by permission from Coal Miner's Pocketbook.

†Illustration from Transactions A. I. M. E., Vol. 49, by permission.

CLASSIFICATION OF PUMPS AND DEFINITIONS.

Pumps may conveniently be classified according to (1) motive power, as steam, electric, compressed air pumps, etc., (2) construction and operation, as duplex pumps, centrifugal pumps, power pumps, etc., and (3) the use to which they are put, as mine pumps, boiler-feed pumps, sinking pumps, deep-well pumps, etc. In order to have a clear understanding of terms which are commonly used in mine drainage, definitions will now be given of the various names by which pumps are known.

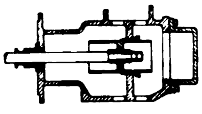
Fig. 9. Plunger Pump.

The plunger pump is so named from the solid rod, cylindrical in section, which puts the water into motion by displacing a volume equal to the part which is thrust into the water end. See Figs. 9 and 13. The plunger pump is the one generally used for boiler feeding.

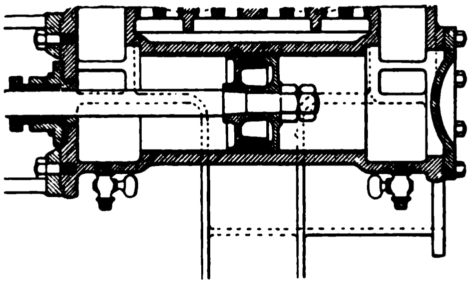
Fig. 10. Piston Pump.

The piston pump uses a disc which closely fits the bore of the water end and forces the water before it. See Fig. 10.

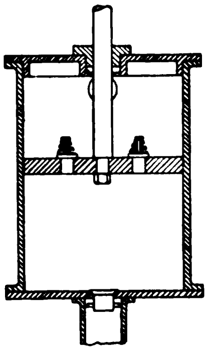
Fig. 11. Bucket Pump.

The bucket is a piston containing one or more openings provided with valves which permit the water to pass through at the proper time. See Fig. 11.

The stroke of a pump is the distance the piston or plunger travels within the water end. Pumps with 6-inch stroke should never be run over 50 feet per minute; 10-inch stroke not over 60 feet; 12 inches not over 75 feet; 15 inches not over 90 feet; 24 inches not over 110 feet. These figures are intended for simple pumps only. A compound pump can always be safely run from 10 to 15 per cent. higher in piston speed than a simple pump. These are the maximum speeds for direct-acting pumping machinery and should not be exceeded for safe operation. If run slower packing and repairs will be saved.

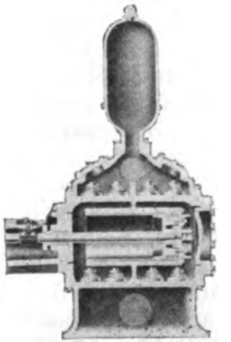
Fig. 12. Double-acting Piston Pump.

Single - acting pumps are those which discharge water while the piston is traveling in one direction. See Fig 11. Bucket pumps and many plunger power pumps are types of this class.

Double - acting pumps are those which discharge water on both strokes of the engine. Piston pumps are good examples of these. See Fig. 12.

Direct - acting pumps are those in which the steam and water pistons are attached to opposite ends of the same piston rod. Steam driven pumps are examples of these and will be found in large numbers in the catalog.

Fly-wheel pumps are direct-acting pumps to which a fly-wheel is attached. This permits the use of steam expansively.

Horizontal pumps are those in which the pump cylinder is horizontal.

Vertical pumps are those in which the pump cylinder is vertical.

Reciprocating pumps are so called because their moving parts travel alternately forward and backward in the same straight line.

Power pumps are those in which the pump proper is driven by means of belts or gearing. See catalog for examples of these.

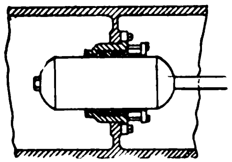
Fig. 13. Inside-Packed Plunger Pump.

Inside-packed pumps include piston and plunger pumps which are packed inside the cylinder. See Figure 13 for illustration of plunger pump.

Outside-packed pumps are those whose plungers are packed outside the cylinder. Examples showing center-packed and end-packed plunger pumps will be found in the catalog.

A single pump consists of one steam and one water cylinder. See catalog.

A duplex pump consists of two single pumps, placed side by side on the same bed plate and having one discharge and one suction pipe in common. In this form the two steam pistons move in opposite directions. The slide valve for one steam cylinder is operated through suitable connections by the piston rod of the opposite cylinder, the D-valve always moving in a direction opposite to that of the piston. See Fig. 14.

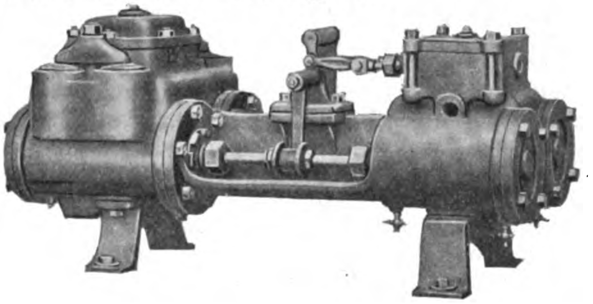
Fig. 14. Duplex Pump.

Triplex pumps are power pumps having three water cylinders.

Multiplex is a term conveniently used to designate power pumps having more than three cylinders, as quadruplex, quintuplex, etc.

A compound steam pump has two steam cylinders of unequal diameter, the steam being passed, after use, from the smaller to the larger where by expanding it continues to do work.

A triple-expansion steam pump has three steam cylinders of unequal diameters, steam from the boilers entering the smallest and passing from here to the intermediate and thence to the largest cylinder. The steam used is thereby expanded in three successive stages.

Condensing steam pumps are those in which the exhaust steam from the low-pressure cylinder is passed to a condenser for the purpose of removing the back pressure of the atmosphere from the exhaust.

A rotary pump is one which by the rotary motion of its tight-fitting part, or parts, forces the water onward. See Fig. 15. Its capacity varies directly with the speed.

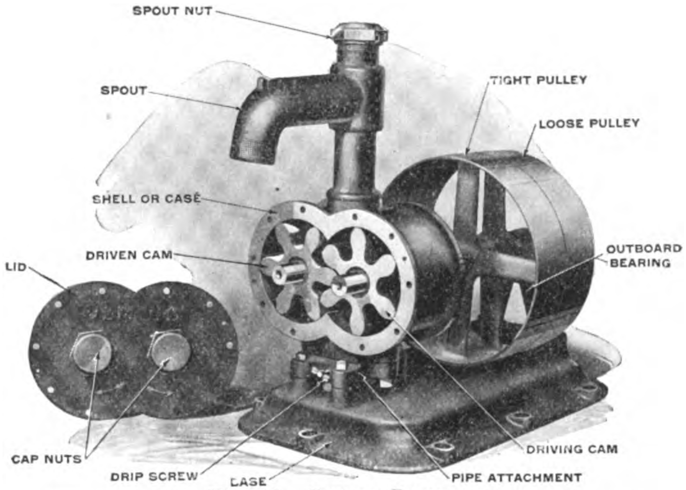

Fig. 15. Rotary Pump.

When the water is moved by centrifugal action by means of a fan wheel operating directly upon the mass of water, it becomes a form of rotary pump known as the centrifugal pump. Unlike the rotary pump, it has tight-fitting parts only at the entrance or eye of the impeller, the rest of the parts having large clearances. See catalog for illustrations of these.

A volute pump is a centrifugal pump which derives its name from the form of casing or shell and usually refers to single stage, although volute pumps may be connected in series for high heads.

A portable pump is one mounted on a truck, usually having the same gauge as the mine tracks, so that it can be conveniently moved from place to place as needed. They are commonly of the plunger type and driven by electricity.

Gathering, auxiliary, or field pumps are those used for unwatering certain sections or depressions in the mine. In shaft mines they discharge either into the main sump, or into ditches leading thereto.

Turbine pumps are centrifugal pumps which derive their name originally because they were fitted with diffusers or guide vanes outside of the impellers, and thus resemble turbine water wheels, but later any pump with concentric casing is so called.

Main pumps are those used to eject the water out of the mine. In shaft mines they are located at the shaft bottom, or else at some central spot, convenient to the gathering pumps. The discharge line may be run to the shaft bottom and up the shaft, or proceed directly from the pump to the surface through a bore hole.

Because of the methods of construction and operation, pumps are disignated as "duplex, piston pumps;" "double-acting, triplex power pumps;" "duplex, double-acting, electric-driven pumps;" "Horizontal, triplex, single-acting, outside-packed, plunger pump;" "duplex, triple-expansion," etc., etc. For illustrations of these and many others see the catalog.

MOTIVE POWER FOR PUMPS.

Steam

Steam, as a motive power, has been in use almost 150 years. Beginning with the Cornish pump with the steam cylinder on the surface, it later was adapted to the direct-acting type of pump placed below the ground, the steam being conveyed in pipes to the pump. Its widely extended use in pumping may be said to be due to the presence of steam as the power medium at most mines, and the ease with which steam mains may be carried down the shaft. When this is at a great distance, the heat losses by radiation become large and the steam pressure low, necessitating a high cylinder ratio. Some of the losses in transmission may be avoided by covering the pipes with heat-insulating material. In the use of steam, care must be taken that the pipes are not in contact with the timbers owing to the danger of fire and the production of dry rot.

The disposal of the exhaust steam from underground pumps occasionally proves troublesome, but in mines which tend to become dry and dusty in the cold seasons, the waste steam may be used to humidify the incoming air current when the force system of ventilation is adopted. When the exhaust is turned into the sump, as is sometimes done, the pump is put to the disadvantage of lifting heated water, and moreover, if acid, the water becomes more active in attacking the metal parts. One great disadvantage in the use of steam underground is the stoppage of the pumps in case of a sudden inrush of water reaching the steam line.

But the greatest objection urged against the ordinary steam mine pump is that it is a heavy consumer of power. Because of the absence of flywheels, whereby energy may be stored up in the early part of the stroke, it is necessary to admit the steam to the cylinder at full stroke, thereby failing to utilize its expansive power. As compared with a steam engine having all the devices conducive to a high efficiency, the direct-acting steam pump uses from six to ten times the amount of steam. For pumping large quantities of water against high heads, compound or triple-expansion pumps may be specified and while these are costly and cumbersome, the saving effected in the consumption of steam more than recompenses for the capital invested.

Compressed Air

The disadvantage which results when steam is not used expansively applies to compressed air as well. Its preference over steam is based on the total absence of heat, thereby eliminating the dangers from fire and dry-rot; the transmission losses are small, and the submergence of the pipe line (in case of flooding) need not interfere with the operation of the pump. Compressed air is particularly well adapted to the operation of gaseous mines where the use of electricity might be attended with danger.

A pump designed for the use of steam can be run by compressed air. In case of an emergency, however, the precaution should first be taken to remove all fittings from the exhaust of the pump, else there may be clogging of the pipe by freezing with the consequent stopping of the pump.

The argument commonly used against compressed air for mining purposes is its relatively low efficiency. However, it should be borne in mind that in many of the necessary operations connected with mining, convenience and safety features may more than over-balance decreased efficiency. It is true that the installation of the compressed air system and its use for the general purposes of mining has only too frequently been attended with unsatisfactory results. It is likewise only fair to admit that in many of these instances the fault with the system lay in careless and incompetent supervision during its construction. In specifying machinery the requirements may be underestimated with the result that the equipment is not proportioned to the work. Matters of prime importance may be overlooked, as the speed at which to run the compressors; the careful selection of a point of air intake free from dust and excessive heat; the proper lubrication; proper size of transmission lines and fittings; the use of receivers; elimination of leakages, etc., etc. Running under the adverse conditions and lax inspection, too generally found at the mines, the efficiency is low and the use of compressed air as a power is condemned, whereas, in truth, with proper construction, materials, operation and maintenance it may be operated on a very satisfactory basis.

Electricity

The favor with which electricity has everywhere been received for underground purposes insured its ready acceptance as a medium for driving pumps. Its general advantages over the use of steam or compressed air may be stated as follows: (1) where more than one mine is being operated it permits the use of a central power plant from which distribution of power may be made to the several mines. This ensures a greater efficiency and lower operating costs in comparison with the individual plants; (2) the system of distribution is more flexible, requires less space and the transmission losses are low. Electric wires are easily carried to remote sections of the mine for the operation of auxiliary pumps; (3) the wires give off no heat as do steam lines and there is no troublesome exhaust to contend with; (4) an additional advantage over steam is that electrically driven pumps, using squirrel cage induction motors, have been known to operate under water, if flooded, and in practice have pumped themselves dry even after weeks of submergence; (5) electric pumps are more portable and require less space; (6) they are more efficient than steam or air driven pumps.

Their disadvantages may be stated briefly as the danger from accidental contact with the bare wires and the possibility of starting a mine fire by the bare conductor coming into contact with inflammable material. In mines where considerable methane is present in the air, it is possible to have an explosion initiated by the arcing of the brushes on the commutator or from the grounding of the live wire. All of these dangers, however, may be minimized by the proper equipment, care and attention.

Gasoline

Gasoline driven pumps are well fitted for use at mines where neither steam nor electricity are available. For inside purposes they are usually limited to small sizes, though power pumps operated by gas or gasoline engines are now built in units of several hundred horse-power. In the larger sizes they may be found well adapted for pumping water from a distant stream, to be used at the mine for watering coke ovens, supplying the washers, reservoir, storage, etc.

Rope Drives

These are but little employed in mining though their use may prove advantageous where the pump is located close to an endless rope system of haulage. By means of a pulley attached to the horizontal sheave, a rope drive can be made to transmit power to a similar pulley driving the pump.† Starting and stopping is effected by means of a clutch.

For the purpose of deep-well pumping, used in some instances to supply water for community purposes, it is well adapted. The engine, in this case, is placed on the surface, vertical with the pump, and connection made between the respective pulleys with a rope.

Water Power

In the early history of mining water power was, for a long period, the principal agent employed in unwatering mines, supply reservoirs being constructed to collect and store the rainfall. Referring to the use of over-shot wheels for furnishing power at English mines, they are said to be "frequently from 40 to 50 feet in diameter, and at Great Laxey mine in the Isle of Man, one of the wheels is no less than 72 feet 6 inches in diameter, and 6 feet in the breast.*

At the Comstock mine, Nevada, there is in use a special hydraulic ram by which 1800 gallons per minute are pumped from the 2600 foot level to the Sutro drainage tunnel at 1600 feet.

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*A Text-Book of Ore and Stone Mining, C. Le Neve Foster, pg. 448.

†See Coal Age, Vol. 11, pg. 503.

DIRECT-ACTING STEAM PUMPS.

This class of pumps became the successor to the Cornish system of pumping, which, because of its expense and cumbersomeness never gained much foot-hold in the United States. The direct-acting steam pump was patented September 7th, 1841, by Henry Rossiter Worthington, its inventor and original builder. In its first form it consisted of one small steam cylinder connected to a force pump, the movement of the valve and the length of stroke being controlled by the motion of the piston rod. The action of the pump plunger, or piston, was an intermittent one, the water column starting and stopping with the beginning and termination of each stroke. thus subjecting both the pump and the connecting pipes and their joints to severe strains. The time and money spent by Mr. Worthington to correct this trouble resulted in his announcing an improved pump, now everywhere known as the "direct-acting steam pump."

For purposes outside the mine this type of pump is used for boiler feed, pumping water from a running stream into supply tanks or reservoirs, drainage of excavations, condenser pumps, etc. For underground purposes, they are used as main pumps, being particularly well adapted to the raising of small volumes of water against high heads, and can be applied to lifts of a thousand feet. For this use they are generally duplex and always double-acting.

When used as a main pump having a single cylinder, steam is admitted almost throughout the entire stroke owing to the constant resistance of the plunger. The addition of a fly wheel, whereby energy might be stored at the beginning of the stroke and later released during the expansive working of the steam, is usually prohibited by conditions within the mine, along with the additional expense and mechanisms necessary to secure a single expansion. Compound or triple-expansion steam pumps provide for the economical use of steam but at a higher initial cost for the installation, along with the provision of an enlarged pump room. It is obvious that at metal mines, where the cost of fuel is high, the attainment of a high efficiency by the expansive use of steam is of great importance, though the large number which are in use to-day at coal mines attests to their economy, even where the fuel supply is relatively cheap.

Direct-acting steam pumps are either of the plunger or piston type. Piston pumps are well suited for handling clean water, since muddy or gritty water scours the cylinder lining to such an extent as to make a tight fit difficult. Where the water is highly charged with acid, the piston and cylinder lining are exposed to attack, and under these adverse conditions may require frequent renewal. Piston pumps, therefore, are not used underground. The plunger pump meets these conditions better since the tightness of the plunger is maintained by packing and when worn this can be easily and cheaply renewed.

POWER PUMPS

Power pumps, because of the advantages resulting in the use of electricity as a motive power, have displaced steam-driven pumps in a large number of mines. Where electricity is used in all the processes involved in mining, fuel economy can be obtained by having all generating units driven by engines in which steam is used expansively. Thus the steam demand is low and the electric power transmitted underground to the pumps is furnished at a low cost, impossible to equal with the most economical underground steam-using pump. H. S. Geismer* states that at any mine in which steam or air pumps are used to do all of the pumping, an electric-generating unit and electric pumps could be purchased to replace them, and the entire outlay be paid for in the saving obtained within 18 months at most.

Power pumps are found in use as main pumps where the pressure is not heavy, and as auxiliary pumps for the handling of water in local basins or dip sections. They may be single, duplex, triplex or multiplex; piston or plunger pumps; single or double-acting; and driven either by belts or gearing, or both.

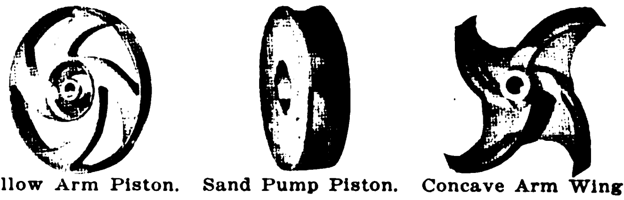
A survey of the coal fields establishes the fact that the portable power pump, driven by an electric motor, has supplied a need in mining. The facility with which the truck on which the pump and motor are mounted may be moved from one section to another and connection made with the trolley or machine circuit has given it prompt recognition. In development work, it may be shunted into cross-cuts or refuge holes and moved forward as necessity demands. Pumps for this kind of work are either single or triplex, depending upon the quantity of water encountered; power pumps, when used as main pumps, are usually triplex or multiplex.

Where electricity is used the speed of the motor is reduced by means of gearing interposed between the armature shaft and the crank shaft. In duplex pumps the cranks are set 180 deg. apart, if single-acting, and 90 deg. apart, if double-acting; in the triplex pump the cranks are 120 deg. apart. This setting insures a steady flow in the discharge pipe.

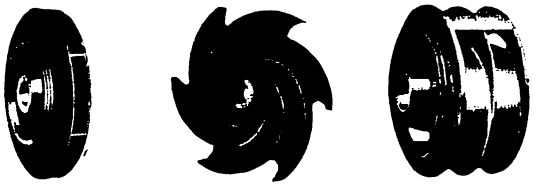
Centrifugal Pumps

Centrifugal pumps, working in single stages, have been used for many years where the lift is low. In recent years multi-stage pumps have been designed which operate successfully against heads in excess of 1000 feet. Because of their marked advantages they are lively contenders for supremacy in mining work. They are in use as main pumps, auxiliary pumps and boiler-feed pumps.

The centrifugal pump bears the same relation to the reciprocating pump that the steam turbine bears to the reciprocating engine. The principle involved in their operation is different from that found in the reciprocating pumps, inasmuch as, instead of displacing water by pressure, discharge is effected by centrifugal force developed by revolving impellers. See Fig. 16.



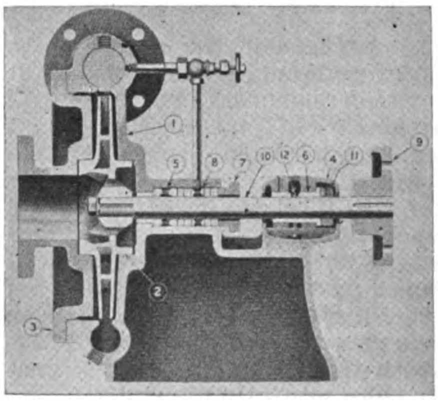
Hollow Arm Piston. Sand Pump Piston. Concave Arm Wing.



Enclosed Side-suction Impeller. Open Impeller. Enclosed Double-suction Impeller.

Fig. 16. Types of Revolving Impellers.

Its operation is as follows: The impeller being set in rapid motion tends to throw outward, by the centrifugal force developed, the water which fills the casing. The only outlet to this moving water is the delivery pipe, opening at a tangent to the casing, and through this the water is forced at a high velocity. The resulting void in the pump is filled with inflowing water coming through the suction pipe and admitted to the center of the impeller. See Fig. 17.



1—Cast iron casing.
2—Bronze runner.
3—Cast iron cover.
4—Cast iron bearing cap.
5—Bronze bearing bushing.
6—Babbitt bearing bushing.
7—Cast iron gland.
8—Bronze water-seal ring.
9—Flexible coupling.
10—Steel shaft.
11—Steel set collar.
12—Bronze oil ring.

Fig. 17. Section through Single-stage Centrifugal Pump.

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*Coal Age, Vol. 10, pg. 378.

Single-stage pumps may be used against lifts as high as 200 feet, though 150 feet is generally regarded as the advisable high limit. When the heads become excessive pumping in stages is resorted to. In this form each impeller revolves in its own chamber, and delivers the water, usually through a diffusion vane into the succeeding impellers, each impeller increasing the head in proportion, and finally into the delivery pipe. See Fig. 18.

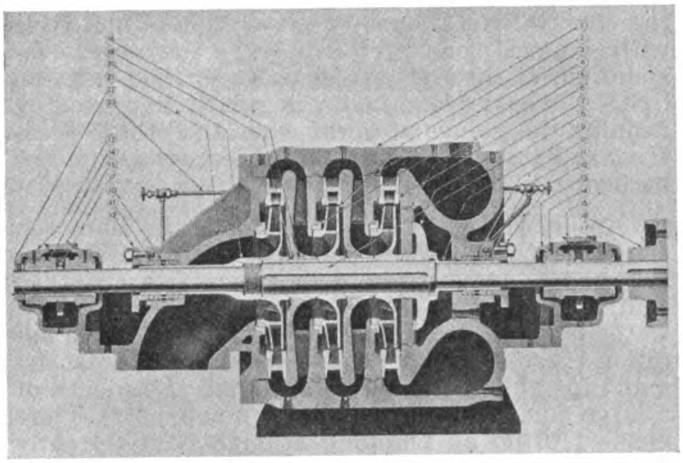

Fig. 18. Section through Multistage Centrifugal Pump.

1—Cast iron casing.
2—Bronze enclosed runner.
3—Cast iron return guide.
4—Bronze wearing ring.
5—Cast iron thrust plate.
6—Bronze diffusers.
7Balancing disc.
8—Open hearth steel shaft.
9—Bronze shaft sleeve.
10—Bronze water seal ring.
11—Packing.
12—Cast iron glands.
13—Cast iron bearing cap.
14—Cast iron babbitted shell.
15—Cast iron hinged lid.
16—Cast iron flexible coupling.
17—Bronze oiling ring.
18—Bronze return guide bushing.
19—Bronze spacer sleeve.
20—Bronze shaft sleeve.
21—Cast iron suction cover.
22—Cast iron set collar.
23—Water seal piping.

The diffusion vanes are held rigidly in place and serve the purpose of guiding the water as it leaves the impeller into suitable passages whereby its velocity is reduced. In this way the kinetic energy of the mass, due to its velocity, is converted into static energy, or pressure head. The impellers are set side by side on the same shaft. The stage of the pump is usually indicated by the number of impellers, or revolving parts. Thus a two-stage pump has two impellers, a three-stage has three impellers, and so on.

The majority of installations of centrifugal pumps is below 1000 feet, though a few exceed this. A centrifugal pump is successfully operating in the Penn Iron Mining Company's mine at Vulcan, Mich., and delivers 1000 gallons per minute against a head of 1300 feet. This is done in eight stages, four being placed on each side of the driving motor. Modern installations seem to indicate that centrifugal pumps may be successfully used for heads up to 2000 feet.

The favorable features of the centrifugal pump are as follows: (1) it is simple in construction, having no valves or sliding parts and only one moving part, the impeller, which is rotated by a direct connection to the prime mover, either a steam turbine or electric motor having a high rotative speed. Thus there are no pulley wheels or gears to absorb power. The impeller is in continuous motion, in contrast to the reciprocating motion of piston or plunger pumps, a point of much importance, as any mechanical device having a rotary motion is to be chosen in preference to one which is reciprocatory; (2) because of its simplicity it is durable and compact and has a low cost of maintenance. It has a maximum capacity with minimum dimensions. Its space requirement may be judged by the recent installation of a five-stage unit, direct connected to a single-stage steam turbine, both mounted on the same base. Its heighth is four feet and length 10 feet, yet the combination has a capacity of 1000 gallons per minute against an average discharge pressure of 270 pounds. The quality of compactness has made it particularly applicable to the unwatering of flooded shafts, where in the interest of despatch, more than one pump is desirable; (3) where a spare unit must be provided for emergency use, the centrifugal pump offers an advantage because it is cheaper than a reciprocating pump; (4) centrifugal pumps are preferable for pumping a large amount of water against a small head; (5) since there are no valves there is a total absence of water hammer; (6) should the valve on the discharge line be closed while the pump is in operation, no harm can result to either pipe line or pump since the pressure exerted can never exceed that due to the velocity of the impellers; (7) centrifugal pumps are more easily kept up to their initial efficiency and the cost of maintenance is less than with reciprocating pumps.

The disadvantages met with are: (1) because of the high speed of rotation, centrifugal pumps are more effected by gritty water than reciprocating pumps. This may cause serious damage to the guide vanes and impellers; (2) owing to their construction it is difficult to line them for protection against acid waters. Wood linings are not adaptable though cement linings may be used. The pump, however, may be made of special acid-resisting metal, or have a wood body in which the volute is cut; (3) centrifugal pumps are less efficient than reciprocating pumps, though this is partially offset by the greater efficiency of the high-speed motor used for driving, as compared with the low-speed motor used with reciprocating pumps. Lack of attention to valves in reciprocating pumps may, of course, make them less efficient than the centrifugal type; (4) all centrifugal pumps are designed especially for the work they will be expected to do, that is, a certain number of gallons delivered each minute against a stated head. Any variation in this affects the efficiency of the pump. Since gathering pumps must meet continually varying conditions of service, it will be seen that the centrifugal pump is, in this respect, not well fitted for this kind of work. As a main pump, wherein the head is constant, it is particularly well suited; (5) centrifugal pumps require a short suction line and a low lift to work the most satisfactorily owing to the necessity of keeping the pump primed. This also operates unfavorably to their use as a gathering pump, since these, at times, are obliged to have long suction lines; (6) the end thrust, due to water entering the pump at one side of the impeller, has in the past been a source of power loss. In the later designs this is eliminated by having a double suction, one on each side of the impeller. Any unbalanced thrust is neutralized by collars mounted on the pump shaft. Practically all builders of multi-stage pumps are now building pumps with single-suction runners and using some method of hydraulically balancing same, the most favored type being the balanced disc.

The efficiency of the better class of pumps will run from 45 to 75 per cent. depending on the size of the pump and the conditions under which it is run.

MINE PUMPS

Mine pumps are subject to hard usage. Frequently they are so located that inspection can be made only with difficulty, and neglect follows. In times of heavy inflow, with pumps of insufficient size, they may be called upon to work continuously day in and out at a speed considerably beyond normal. The requirements of a mine pump differ in some respects from those put to a different service. Assuming a large pump is to be taken into the mine, the various parts will need to be sectionalized to such an extent as to allow their passing through the shaft. The difficulties in erection must be provided for by having the castings of such size and weight that they may be readily assembled. The pump must be reliable and capable of giving continuous service, with its mechanism as simple as is consistent with efficiency. Because of the acid condition of most mine water, the pump end must be of such materials and design as to withstand corrosion. The use of a number of small parts of similar form makes it possible to renew the parts affected without need of replacing a whole pump end.

Lubrication and re-packing should be easily attended to and replacements and repairs effected in a minimum of time. All wearing surfaces should be large in proportion to the weight of the moving parts. Lastly, the efficiency of the installation should be high. Since this, in the final analysis, works back to the fuel consumption, it has in the past been too generally the practice to disregard its importance at coal mines. When it is remembered, however, that a simple pumping engine will require from 75 to 120 pounds of steam per delivered horsepower per hour, while a triple-expansion engine requires but from 20 to 22, the economy in the use of high efficiency units becomes more apparent.

Pump Room

Pump rooms, well lighted and protected from falls of roof, are essential to the proper use of pumps. Since the heat from the steam cylinders is destructive to wood, and for the further reason of guarding against fire, steel I-beams are finding their way into more general use for this purpose. Concrete makes a dry and serviceable bottom, and when carried up on the sides between the steel supports prevents the crumbling of the walls.

The size of the pump room will depend upon the type of equipment used. Direct-acting steam and compressed-air pumps require more space than power pumps of the same capacity, and if these are compound or triple-expansion and condensing, the space requirement will be quite large. For instance, compound condensing pumps having a capacity of 2500 to 3000 gallons per minute are in use, weighing close to 100 tons and requiring a pump room approximating 22 feet by 65 feet by 13 feet.

Sumps

The main pumps are commonly provided with sumps wherein water may be stored, making repairs possible when needed without danger of inundation. A second great advantage of ample sumpage, where the pumping capacity is in excess of the need, is that the pumps are required to run only a portion of each day. If steam is the motive power, it will equalize the demands on the boilers to have all the pumping done on the night shift. The economy may be more pronounced when electric power from a central station is used. Since the charge for power is based partly on, and rises with, the peak loads, the more even the power consumption is throughout the full day, the less the cost. Hence the load factor is greatly improved by running the pumps at night when the other operations as hauling, hoisting and undercutting are not needed.

An illustration of this is found at the Hampton sump of the Delaware, Lackawanna and Western Railroad Company, where there are two six-stage centrifugal pumps which deliver 5000 gallons of water per minute against a 500 foot head. In addition there is a water hoist, making the total demand for pumping 2800 horsepower. By means of a large sump holding a half-day's supply, they are enabled to do all pumping at night, thus greatly aiding the load factor.

Boiler-Feed Pumps

These are usually reciprocating pumps, either simple or duplex, and piston or plunger. It is essential that they be as simply constructed as possible and have few parts liable to breakage. Because of the importance they bear to the continuous operation of the plant, there should be a duplicate unit held in reserve. Boiler-feed pumps handle either cold or hot water, depending upon whether the water supply is pumped through the heater to the boilers, or from the heater to the boilers. The latter is the more usual arrangement and, owing to the high heat of the water, requires that there be no suction lift to the pump and that its speed shall not exceed 60 feet per minute. In most installations the speed falls below this and at these slower speeds it is customary to omit air chambers as a part of the equipment.

The steam cylinder is generally 2¼ to 3 times the size of the pump cylinder, in order that there may always be ample power to force water into the boilers against the pressure of the steam.

For the heavier steam pressures the duplex compound steam end with the pot-valve type of pump end is in common use with the advantage of greater economy in operation, and facility of valve inspection. See Fig. 19.

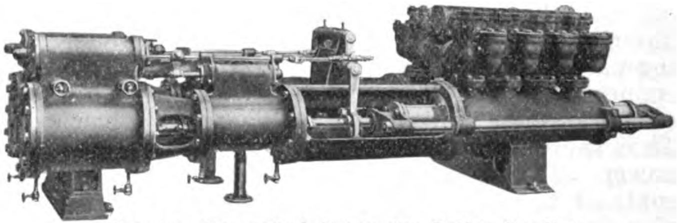

Fig. 19. Compound Pump for Boiler Feeding.

The steam turbine-driven multi-stage boiler-feed centrifugal pump is one of the latest developments where the capacity is not less than 150 to

200 gallons per minute. It occupies much less floor space than any other type and insures a continuous flow of water without pulsations. See Fig. 20.

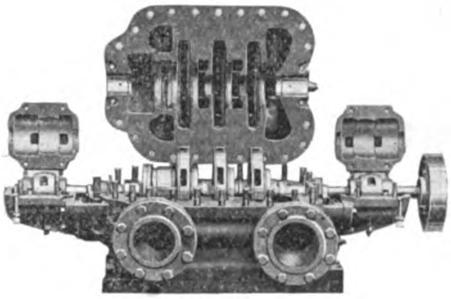

Fig. 20.

Sinking Pumps

During the process of shaft sinking it becomes necessary to keep the bottom free from water. Any ordinary horizontal pump could be used for this purpose but because of the limited shaft space and the operations incidental to shaft sinking, it is far more convenient to use a vertical pump, hung in the shaft close to the excavation, and supported by a chain or cable extending from the pump to the surface, and thence to a steam winch or chain block, by which means the pump can be raised or lowered as required. A common type is one where the pump is mounted on a frame which fits the timbers of the shaft and supports the pump while in its normal position. See Fig. 21.

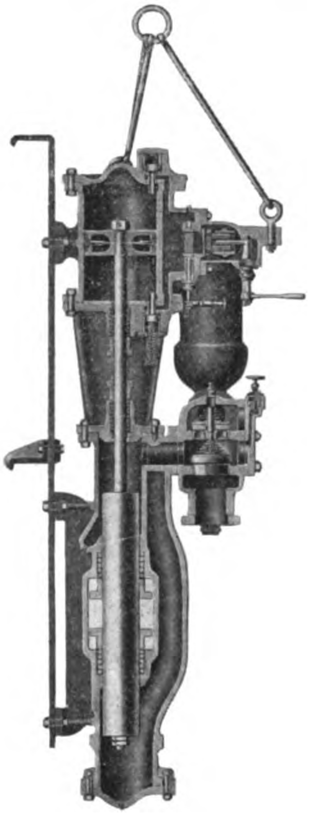

Fig. 21. Section View of a Sinking Pump.

As excavation proceeds the pump is lowered, and when blasting is to be done the pump may be raised to prevent injury from flying debris.

Sinking pumps are either simple or duplex, usually plunger, outside-packed, and driven by steam or electricity. Of all mine pumps, they are most subjected to hard usage, being constantly exposed to damage from flying rocks, materials dropped down the shaft and the knocks received in transportation from place to place. The working parts are protected by enclosure, or by the projection of the cylinder and steam chest. They must be substantially built to operate for long periods with the least possible risk from stoppage, since any interruption might mean the flooding of the shaft. The suction end is at the bottom of the pump and the water is conducted to it by means of a telescopic section, or more commonly, a flexible hose.

Electric sinking pumps embody the usual advantages of this type and show a higher operating efficiency than the steam-driven pumps. The entire motor mechanism is enclosed in a tight casing which is so constructed as to be easily accessible for inspection and repairs. The use of this type of pump requires a larger electric generator, as a part of the contractor's equipment, than where electricity is used merely for shaft lighting.

In order to avoid the disadvantages of the ordinary sinking pump, namely, the delays incidental to the raising and lowering of the pump and the rough usage it receives in the shaft, a triple-plunger deep-well pump has been designed.* This is intended to lift water from considerable depths by means of a working barrel placed in the water near the bottom of a bore hole which is drilled adjacent to, but just outside of, the side of the shaft that is being sunk. The depth of the bore hole exceeds that of the shaft by a few feet. The water met with in sinking is admitted to the bore hole at intervals by holing through the intervening strata. It is then forced from the bottom of the bore hole through the column pipe to the surface.

Centrifugal sinking pumps have recently come into use and a wider application to this work may be expected. In fact fully a dozen leading manufacturers are now designing and recommending types of centrifugal pumps exclusively for shaft-sinking purposes.

Pulsometer

The pulsometer is a type of pump in which the water is expelled by the pressure of steam directly touching its surface. It is extremely simple in construction, containing no reciprocating parts and requiring no lubrication. Its particular field of usefulness lies in pumping sandy or acid waters to a heighth not much in excess of 30 feet. At low lifts its capacity may be quite large, some pulsometers exceeding 1000 gallons per minute being in use. It is particularly applicable for use about coal-washing plants where water is to be re-used by pumping from the settling tanks to the jigs.

The operation of the pump is as follows: Steam from the boiler is admitted to the pump at the top, and enters either the right hand or left hand chamber, a, depending upon the position of the steam valve C. This steam valve is a ball which is free to roll to the right or to the left and forms a

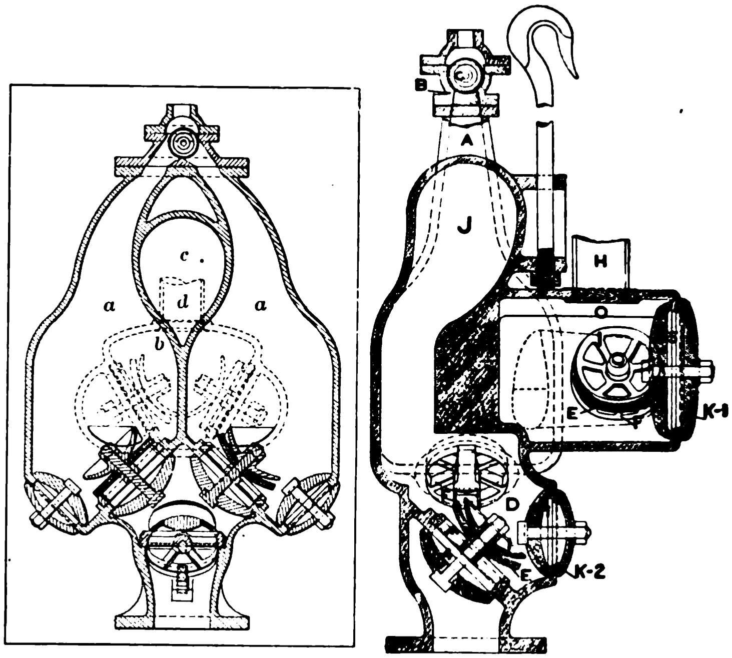

Fig. 22. The Pulsometer.

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*Coal Age, Vol. 7, pg. 761.

steam-tight joint with which ever seat it rests upon.

As shown in Fig. 22 the steam would pass to the left hand chamber, a, which we will assume is full of water. The pressure of the steam depresses the surface of the water without agitation, forcing the water out of chamber, a, through a passage (not shown in the figure) and a check valve, F, (dotted) into the discharge chamber, O, thence to the discharge pipe, H. The moment the water falls to the level of the opening leading to the discharge chamber, the even surface of the water is broken up and, owing to the peculiar form of the pump chambers, the water and steam are thoroughly churned up and brought into intimate contact, causing instant condensation of the latter. This forms a vacuum in the left hand chamber, which, assisted by a slight upward pressure in the right hand chamber, immediately pulls the ball valve, C, over to the left hand seat, shutting off the steam supply. The vacuum in the left hand chamber now draws up a new charge of water through the suction pipe. While the left hand chamber is filling up, the right hand one is emptying. This brings us back to the start of the cycle and the entire process is ready to be repeated.

The Harris System

The Harris system of pumping with compressed air derives its name from the inventor, Professor Elmo G. Harris. The pump consists of two tanks, each connected with the compressor by a single air pipe. See Fig. 23. The tanks may be submerged, in fact this is preferred when convenient. The operation is as follows:* "At a certain period of the cycle of operation one tank, No. 1, will be full of compressed air, which has just driven the water out, while the other tank, No. 2, has just filled with water. At this moment a 'switch valve' with which the two pipes connect in the compressor room, will automatically reverse the compressor's connection with the two tanks, and the compressed air in tank No. 1 will pass back through the compressor and over into tank No. 2, driving the water therefrom. The compressor gradually exhausts the air from No. 1 until the pressure in the tanks goes below that of the water outside; then water will flow in until No. 1 is full of water and No. 2 is full of compressed air, at which time the switch reverses the connection as before — and so the operation continues."

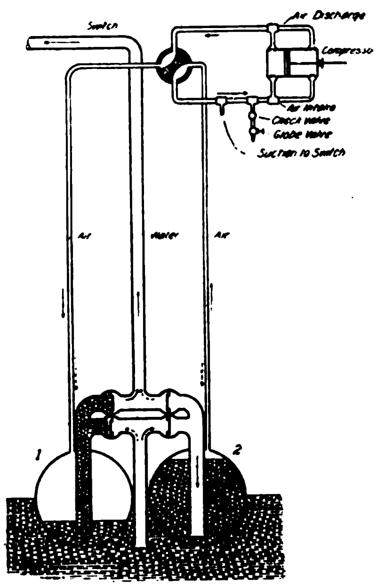

Fig. 23.
The Harris System of Pumping.

The system was devised principally for mine use and has a number of advantages; all of the machinery that requires inspection is above ground; flooding the mine will not injure the pump; the only losses of energy are those due to friction of air in the pipes and some radiation of heat, and the tanks may be any distance from the compressor.

SUCTION LIFT OF A PUMP

Everywhere about us is air. In reality, we live at the bottom of an ocean of air. Since air has weight, it likewise has pressure. This pressure is sufficient, at sea level, to raise water 34 feet in a sealed tube from which all the air has been extracted. When the piston in a pump has reached the end of its stroke and begins its travel in the reverse direction, there is neither air nor water, theoretically, in the space resulting. A vacuum is created, into which water from the sump is forced by virtue of the pressure of the air upon it. The expression 'suction lift of a pump' is therefore a misnomer, since it cannot be other than the pressure of the atmosphere that causes the water to rise through the suction pipe into the pump.

The height to which water can be lifted by atmospheric pressure is plainly the high limit to which water can be raised into the pump by virtue of the vacuum created within the water end. At sea level, as before stated, this is 34 feet. In practice, however, a perfect vacuum in never attained, and a suction lift of more than 25 feet should not be attempted owing to: (1) leakage of air into the suction line; (2) the presence of more or less air absorbed in the water itself; (3) frictional resistance and (4) the water vapor present in the cylinder. The last mentioned is more pronounced with hot water than with cold, which explains the injunction to always locate boiler-feed pumps below the level of the heater.

Since the pressure of the atmosphere decreases as the altitude increases, the suction lift of pumps is less in places of high altitude than in low. The table "Barometric Pressures" on page 544 shows the lift which may be attained in actual practice.

To guard against the entrance of splinters of wood or other foreign substances into the suction line and pump where they might lodge permanently beneath the valves, thus preventing their proper action, a strainer made of wire, or a drilled plate should be used. A foot-valve is always recommended, especially for large installations. Frequently the strainer and foot-valve are combined in one fitting. See Fig. 24.

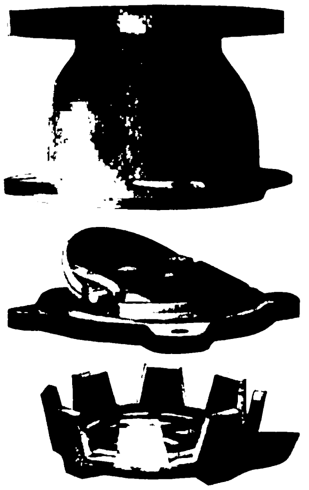

Fig. 24. Combined Strainer and Foot-valve.

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*From the inventor's description, Mines & Minerals, Vol. 25, pg. 513.

AIR AND VACUUM CHAMBERS

The flow of water from a simplex pump is intermittent, consisting of a continuous series of stops and starts. This results in excessive shock and vibration which in time effects the pump, causing leaky joints and broken castings. All simplex pumps, to insure a steady flow, should have an air chamber. The discharge from a duplex double-acting pump is far more regular but the action here also is greatly improved and wear and tear reduced by the addition of an air chamber.

Air chambers vary in size, design and location with respect to the pump. Fig. 25 shows the air chamber usually found on small simplex pumps; Fig. 26 represents the form used where larger air chambers are required, and Fig. 27 is for the largest installations. The air chamber on the delivery main should be set close to the water end and between the pump and the discharge clack. The form of connection should be such that any air entrapped in the water tends to come into it and not flow past it.

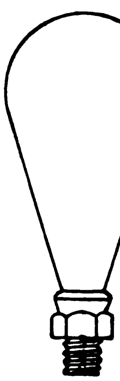
Fig. 25. Air Chamber for Small Pump.

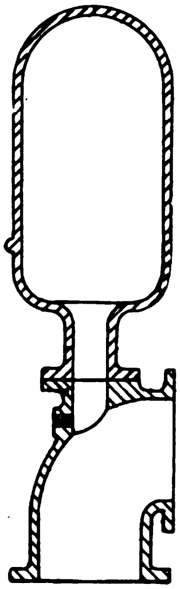
Fig. 26. Air Chamber for Medium Sized Pumps.

The air in the chamber is highly compressed at the beginning of the stroke, making an elastic air cushion whose later expansion tends to keep the water at a constant velocity. If the lift is 300 feet, the pressure upon the air in the chamber will be 300 x .433=about 130 pounds per square inch. An air chamber originally containing nine cubic feet of air at atmospheric pressure would then be occupied by about one cubic foot of highly compressed air and eight cubic feet of water. When under this pressure, air has a tendency to enter into mechanical combination with water so that in time, by the process of this gradual absorption, the air chamber becomes 'water logged', and being without any elastic medium is useless to resist the shocks in the column. This is of such common occurence that the drift of opinion amongst mine managers is generally unfavorable to air chambers. Their value to the life and maintenance of the pump, however, is so great that every effort should be made to reap the benefits they bring. It frequently happens that pumps are speeded during a protracted rainy season. An air chamber permits excessive piston speed with less injury to the equipment.

Some means must be provided to replenish the air which is lost by absorption. Mr. C. W. Crawford suggests an air cock attached to the suction pipe which can be regulated so as to admit merely sufficient air to replace that which has been lost.* A simple mechanical device, really a water-piston pump, may be applied readily at the mine. See Fig. 28. This consists simply of piping connecting the water cylinder and the air cylinder, and in which are located one gate valve (near the pump end) and two check valves (on the horizontal piece) so set as to open toward the air chamber. On the suction stroke of the pump air is drawn through the outer check-valve, the inner check being closed by the pressure in the air chamber. On the force stroke the outer valve is closed and the inner valve opened by the pressure of the water (water piston) in the vertical pipe, which is always slightly in excess of the pressure in the air chamber. When a sufficient quantity of air has been supplied to the air chamber, action may be stopped by shutting the gate valve.

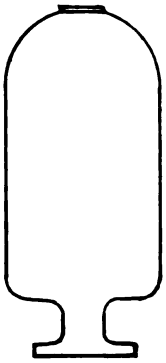
Fig. 27. Air Chamber for Large Pumps.

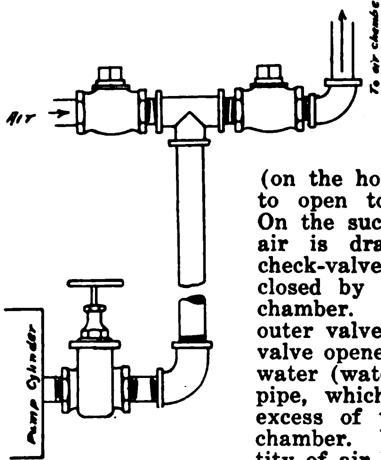

Fig. 28. Pump for Supplying Air to Air Chamber.

A vacuum chamber on the suction side is of material benefit to the smooth working of the pump. Its use is exactly the reverse of that of the air chamber, inasmuch as the vacuum chamber serves to convert a continuous flow into an intermittent one. Its effect is to eliminate water-hammer from the suction end of the pump, and other disturbing influences incident to the continuous flow into it, whereas the emptying of water in the cylinder is intermittent.

PUMP VALVES

Three kinds of valves are used mainly in pumps; clack valves which are hinged; lift, or disc valves, which slide up and down a spindle; and flexible valves, which alter their shape on opening.

Clack valves are shown in Figures 29 and 30. The leather clack valve is one of the simplest forms and is made by cutting a groove out of a circular piece of leather about three-sixteenths of an inch thick. The part of the leather remaining uncut provides the hinge. Iron washers are placed above and below the valve, the upper washer being made large so as to support the weight of the water above the leather. The life of the valve depends upon the number of bends the leather will stand before breakage but the cost of renewal is small. In Figure 31 the leather hinge has been replaced by metal turning on a pin.

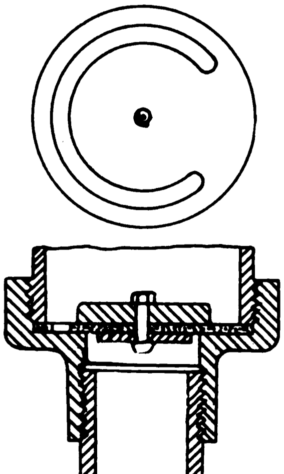
Fig. 29. Clack Valve.

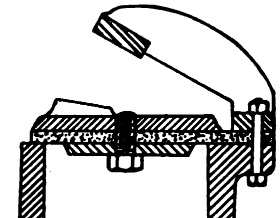
Fig. 30. Clack Valve.

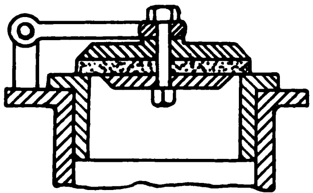
Fig. 31. Clack Valve.

The butterfly valve, Figure 32, is a double clack valve opening toward the center as far as the stop will permit. The valves are generally of metal, faced with leather or rubber, and may be of any convenient shape.

The type of valve best known in mining practice

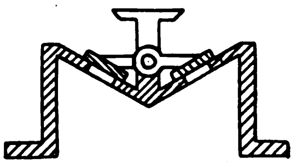
Fig. 32. Clack Valve—Butterfly Type.

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*Coal Age, Vol. 5, pg. 558; Vol. 10, pg. 266.

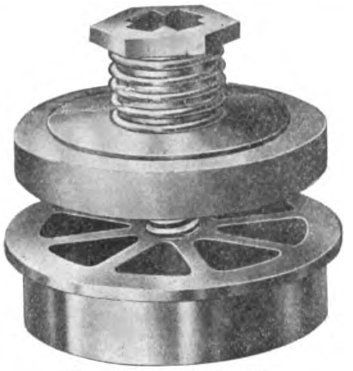

Fig. 33. Disc Valve.

is shown in Fig. 33. The valve seat, spindle, springs and nut are made of composition bronze. The purpose of the spring is to accelerate the closure of the valve. The valve proper is made of composition rubber, or else a high grade of India-rubber, somewhat vulcanized to give the valve firmness. For hot water, a composition of India-rubber and graphite gives good results. Between the spring and the disc is a brass plate which serves to minimize wear and insure an even pressure of the spring to the disc. The valve seat is bound to the spindle support by means of ribs, giving it a gridiron appearance from which it derives its name.

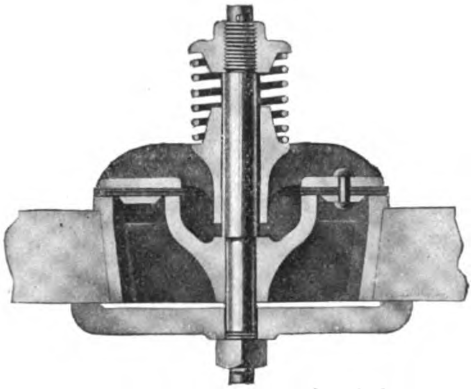

Fig. 34. Ring, or Annular Valve.

The ring, or annular, type of valve is shown in Fig. 34. The valve is faced with leather held in place with rivets. The leather is easily renewed when worn out.

The pot valve, common to most of the large capacity plunger pumps, is shown in Fig. 35. The covers are secured by hinge bolts which can be quickly removed for an inspection of the interior. When handling acidulous waters, the pot is either wood, cement, or lead lined.

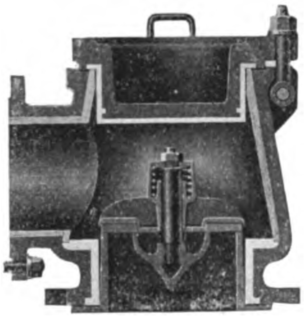

Fig. 35. Pot Valve.

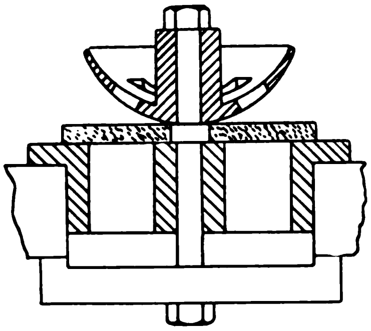

Fig. 36. Flexible Valve.

A type of flexible valve is shown in Figure 36. The guard prevents the valve from opening too far and is provided with slit openings which assist in the quick closure of the valve by giving the water ready access to the disc.

The opening of suction valves in pumps is due to atmospheric pressure, while the opening of discharge valves is due to the water pressure beneath. The closure of all valves should be rapid, though without the producing of shock. Delayed closure of valves enables some of the water to slip back through the valve.

Choice is offered in pump design between the use of a large number of small sized valves, or a small number of large sized valves. American practice leans toward the former, the common custom being to use rubber discs of between three and four and one-half inches in diameter. The reason for this is that the ratio of discharge area to valve area is greater in small sized valves than in large valves, since the area of the valve varies as the square of its diameter, while the discharge area varies as the first power only. (The discharge of water through the valve seats has to do with the area only; the passage of the water beneath the valve into the chamber has to do with the circumference only.) Furthermore, the large sized valves require heavier and thicker discs, which in turn require a larger annular seat. The difference between the upper and the lower area of the disc is therefore large, making necessary an excessive pressure from below before the valve is raised. The larger size disc types may be made with multi-ports as in Figure 37 and in this way utilize some of the central area for discharge.

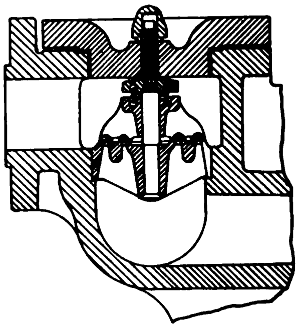

Fig. 37. Disc Valve with Multi-ports.

The question of how much area to provide for the passage of water through the valves is capable of solution by mathematical means, but two rule-of-thumb methods which afford fairly reliable results are here given. One is to have the total valve area equal to a certain percentage of the piston area. Mr. C. A. Hague recommends the following: have the valve area equal to 50 per cent. of the piston area when the piston speed is 100 feet per minute, this to be increased to 150 per cent. when the piston speed becomes 300 feet per minute. Intermediate values are to be derived by interpolation. The piston speed is not being considered so much in recent years as the strokes or reversals. Good practice in pump designing is for the velocity of flow of water through the suction valves to be somewhere around three feet, and velocity through the discharge valves about four feet. Mr. I. H. Reynolds states as his rule that one square foot of valve area be provided on the suction and on the discharge for each million gallons capacity per 24 hours.

CORROSION OF PUMPS

Not only must pump ends be designed to discharge a stated quantity of water against a stated pressure, but the corrosive action of mine water must also be provided for. This is due mainly to the sulphuric acid which is present in varying quantities in nearly all mine waters. In some mines as much as 75 grains of free sulphuric acid per gallon of water is found, while in a few of the most troublesome this may reach 160 grains,* in one instance 225 grains. Under such conditions a pump end of cast iron would be literally eaten up, and many have failed from such cause with but six weeks of service.

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*For analyses of mine waters, see "Chemistry in Coal Mining," by A. G. Blakeley, Coal Age, Vol. 10, pg. 296.

Iron body pump cylinders and valve chambers, cast of a special mixture of hard close-grained iron, and having bronze cylinder linings, valves, spindles, valve seats, piston and piston rod have been adopted. Pump cylinders cast of solid bronze are in use, and though costly, are economical when compared with iron. The alloys mainly used are pure bronze (copper 89%; tin 11%); zincy bronze (copper 88%; tin 8%; zinc 4%); and phosphor bronze (copper 94%; tin 6%; some phosphorus), though proportions may vary slightly. Zinc is added to eliminate air bubbles in casting and to make the alloy more solid, and phosphorus acts as a deoxidizer to clean the metal from the oxide of copper. It is true of most alloys that though ever so uniformly mixed when in a melted state, it is usually a conglomerate mixture after cooling, somewhat like granite, and thereby is the more easily corroded. When bronzes containing zinc are used, the zinc is attacked by the acid and in time the surface becomes pitted and rough. Phosphor bronze must be skillfully handled in mixing and casting to avoid air bubbles and is quite expensive.

Water cylinders of cast iron and lined with wood, sheet-lead or cement have come into extended use. The wood selected is white pine, free from knots. The cylinder is lined with accurately fitted staves about ¾ inch thick and grooved to insure a close fit. When wet the lining swells and becomes tight. All parts which can not be protected with wood, such as valve seats, spindles, springs, nuts, etc., are of acid resisting bronze, and the valve disc of rubber. The experience in the anthracite region, where severe conditions are encountered, has shown that wood-lined pumps are a success. The lining should always be kept wet.

Lead-lined pumps have the exposed parts of the water cylinder protected with sheet lead, and since metallic lead is scarcely attacked by dilute sulphuric acid, a very satisfactory resistant is provided.

Cement is being used as a pump lining and has in its favor low first cost and the cheapness with which it may be renewed. Some trouble has been encountered by the cracking of the cement, leaving openings through which the acid can attack the iron.

SIZE AND CAPACITY OF PUMPS

To find the quantity of water delivered by a pump per minute, multiply the displacement of the piston or plunger per stroke in cubic feet by the number of strokes per minute, and by 7.48, the number of gallons in a cubic foot. Expressed as a formula this is,

Formula 1.

$$G = \frac{D^2 \text{ X } .7854 \text{ X } L \text{ X } N \text{ X } 7.48}{144} = .0408\ D^2 L\ N$$

Where G=gallons delivered per minute.
D=diameter of the piston or plunger in inches.
L=length of stroke in feet.
N=number of effective strokes per minute.
7.48=number of gallons in one cubic foot of water.

The quantity so found will be the theoretical one and exceeds the actual quantity delivered because of the slip of water past the piston and back through the valves while they are in the act of closing. Furthermore, the length of the stroke varies constantly so that its actual travel will differ somewhat from the calculated travel. The slip in a pump ranges from 2 per cent. to anything above, depending on the tightness of the valves and piston, or the presence of obstructions which prevent the proper closing of the valves. A pump, to be efficient, should not show more than 5 per cent. of slip.

When the quantity of water to be raised per minute is known, the size of the pump required can be calculated by the converse of the above formula

Formula 2.

$$D = \sqrt{\frac{G}{.0408\ L\ N}} = 4.95\sqrt{\frac{G}{L\ N}}$$

The theoretical work of the pump will be the weight of the water pumped per minute multiplied by the distance through which it is raised in feet. This product divided by 33,000 will be the horse-power, thus,

Formula 4.

$$HP = \frac{G \text{ X } 8.33 \text{ X } H}{33{,}000}$$

Where G=gallons of water delivered per minute.
H=total height of lift in feet.
8.33=weight of one gallon of water in pounds.

The pressure of water is a function of its height and may be expressed this,

$$p = .433\ H.$$

Where p=pressure in pounds per square inch.
H=height of lift (head) in feet.
.433=pressure in pounds per square inch due to a head of one foot of water.

Let us assume, for example, that 500 gallons of water per minute are to be pumped to a height of 300 feet. The pressure per square inch on the water piston would be

$$p = .433 \text{ X } 300 = 130\text{-lbs.}$$

Assuming the length of the stroke to be 18 inches, and the number of strokes to be 60 per minute, the area of the water piston may be found by formula (2)

$$D = 4.95\sqrt{\frac{G}{L\ N}} = 4.95\sqrt{\frac{500}{1\frac{1}{2} \text{ X } 60}} = 11.7, \text{ say 12 ins.}$$

The total pressure, P, on the piston is found by multiplying its area in square inches by the unit pressure, thus,

$$P = 12^2 \text{ X } .7854 \text{ X } 130 = 14702.7 \text{ lbs.}$$

The size of an engine cylinder necessary to overcome this pressure is easily found when the steam pressure is known. Assuming this to be 80 pounds per square inch at the pump, we have, theoretical area of cylinder in square inches$= \frac{14702.7}{80} = 183.8$

One-half of this area should be added for frictional resistance,

$183.8 + 91.9 = 275.7$=required area of steam cylinder

$$\sqrt{\frac{275.7}{.7854}} = 18.7 \text{ inches, say 18 inches diameter}$$

A pump, therefore, having an 18 inch steam cylinder, 12 inch water piston and an 18 inch stroke, or as expressed by the manufacturer, 18″ x 12″ x 18″, will meet the requirements.

Duty

The duty of a pumping engine has, in the past, been measured by the number of foot pounds of work performed per 100 pounds of coal consumed. With this method any fault in the boilers, boiler setting, chimneys, grates, pre-heating of feed water, etc., was, of necessity, a detriment to the performance of the pumping unit, inasmuch as there was no division of efficiency. In addition, the duty of a pump at a plant using a high grade Pocahontas or New River coal would be considerably higher than where a low grade coal was in use, though the pump performance taken by itself, in the latter case, might, in reality, exceed that of the former. The difference in results might be entirely due to the variation in the heating value of the fuel used, or the inefficiency of the boilers, and therefore furnish no reliable information whereby comparison of pump efficiencies might be made. For the purpose of furnishing comparable data, duty is better defined as the number of foot pounds of useful work done by one thousand pounds of commercially dry steam, or one million British thermal units of heat used by the pump. These values are selected because they approximate the old standard of 100 pounds of coal. The average pound of coal is assumed to give to the water in the boiler about 10,000 B. T. U's, which for 100 pounds would total 1,000,000 B. T. U's; likewise it is further assumed that 100 pounds of coal can evaporate 1000 pounds of steam.

A high duty engine is one which gives an exceedingly high number of foot-pounds of work done. The lowest duty is had with the smaller pumps taking steam continuously throughout its stroke; the highest duty is attained by using superheated steam expansively and turning the final exhaust into condensers. The useful work done by the pump is found as follows: [*]

$$W = Q\,(144p_1 + wh + 144p_2)$$

where W is the total useful work
w is the weight of one cubic foot of water
p_1 is the pressure head in the discharge main in pounds per square inch as determined by a pressure gauge.
p_2 is the vacuum in the suction pipe in pounds per square inch as determined by the gauge or a mercury tube.
h is the distance in feet between the two gauges
Q is the total number of cubic feet pumped, which may be determined in any one of five ways; first, by displacement calculations; second, by weirs; third, by meters; fourth, by weighing; fifth, by measuring.

The total heat chargeable to the engine is next found, then,

$$\text{Duty} = \frac{\text{Foot-pounds of work done}}{\text{Total No. of heat units consumed}}\ 1{,}000{,}000$$

The efficiency of the centrifugal pump is the ratio between the useful horsepower and the applied horsepower, thus,

$$\text{Efficiency} = \frac{\text{Useful Horsepower}}{\text{Applied Horsepower}}$$

The applied horsepower is determined by means of a dynamometer or calibrated electric motor. The useful horsepower is found according to the equation,

$$\text{U.H.P.} = \frac{w\,Q\,H}{550}$$

where W=weight of one cubic foot of the water pumped.
Q=quantity of water pumped in cubic feet per second
H=total head, including suction head, discharge head and velocity head.

AIR-LIFT PUMPING

Air-lift pumping had its first useful application on the Pacific coast. It was patented by James B. Frizell in 1880 and considerably improved by Dr. Julius I. Pohle, to whom patents were granted in 1886.

The arrangement is remarkably simple, consisting of the eduction pipe for the water and an air pipe which discharges compressed air in bubbles at the bottom of the pump. See Figure 38.

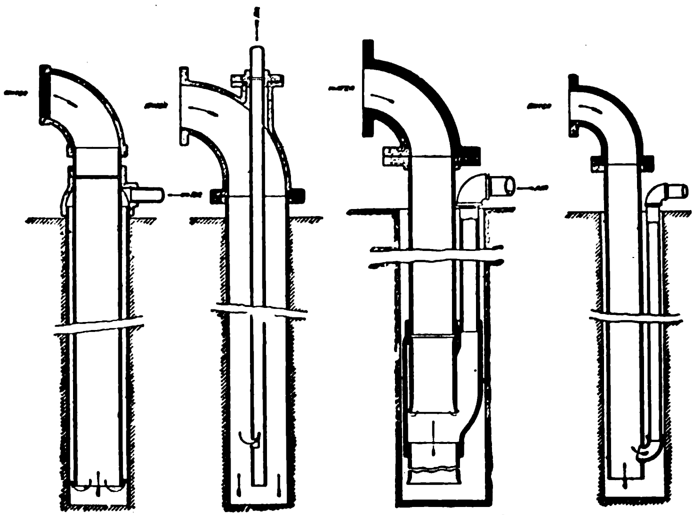

Fig. 38. Methods of Piping Wells.

The air lift contains no movable parts to get out of order, requires no lubrication, handles water that would be destructive to ordinary mine pumps and is not affected by mud or grit. Its principal claim to superiority lies in its large capacity. Under favorable conditions an air-lift pump will discharge more liquid than will any other type.

The principle involved in its action is the decreased specific gravity of the water in which air is contained in considerable quantity, or through which it is rising in bubbles. The lighter aerated water within the pipe is thus forced upwards by the static pressure of the water in the well and a flow created. Since the difference in the specific gravity between the two columns can never exceed a definite amount, it requires that the ratio of submergence to lift be within certain limits. The following table will be of interest.[†]

Ratio of Submergence to Lift.

	Submergence.
For lifts up to 50 feet	70 to 66 per cent.
50 to 100 feet	66 to 55 per cent.
100 to 200 feet	55 to 50 per cent.
200 to 300 feet	50 to 43 per cent.
300 to 400 feet	43 to 40 per cent.
400 to 500 feet	40 to 33 per cent.

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[*] Formula from Greene's "Pumping Machinery," which along with Carpenter's "Experimental Engineering" and Kent's "Pocket Book" are recommended to the student for detailed information.

[†] From Bulletin No. 71-A, Sullivan Machinery Company

The lift may be defined as the static head plus the drop plus the elevation. Drop is the distance the water recedes when the well is delivering a certain quantity of water. Submergence is the depth that the air pipe is submerged below the pumping level of the water in the well. Fifty per cent. submergence means that the total lift, or head, and the submergence are equal. See Figure 39.

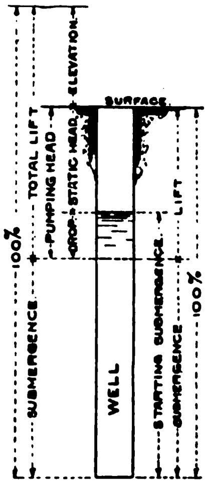

Figure 39. Illustrating Terms Used in Air-Lift Pumping.

In order to avoid the formation of large bubbles in the delivery pipe, a foot piece is used from which the compressed air issues in fine streams, thereby insuring a more intimate mixture with the water. See Fig. 40.

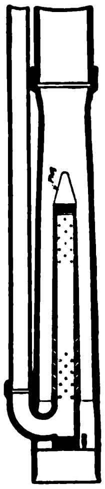

Fig. 40. Foot Piece.

Air lifts have been used for many years to increase the flow from artesian wells for which they are particularly well adapted. The water supply for many cities is derived in this manner. The principle of the system is applicable to certain conditions in mining, such as raising water from the flooded lower sections of a mine to a point where it can be sent to the surface by the prevailing methods. It may be used to great advantage in coal washing for pumping the water from the settling tanks back to the jigs, and sundry other uses.

The efficiency of the air lift depends upon the mixture of air and water, the percentage of submergence and the proper proportioning of the eduction pipe, which bears a definite relation, not only to the volume of water passing through it but also to the air. If the pipe is too large, then there is slippage of the air past the water, unless more air is used to keep up the velocity; or if too small a pipe is used the frictional losses will be large.

While the efficiency of this pumping system may not reach over 40 per cent., its simplicity, the rapidity with which it may be installed in time of emergency and its low first cost may make its utility of more importance than its efficiency. An example of its adaptability to mining is supplied in the unwatering of Crown Hill No. 1 mine, at Clinton, Indiana.* Water had broken into the mine through the caving of an old room, in such quantities as to necessitate the stoppage of work. A drill hole, 160 feet deep, was put down from the surface to intersect an entry in the flooded section, and an air lift installed. The discharge pipe was 6 inches in diameter and inside this was the 1¼ inch air pipe. The mine was successfully recovered by keeping the lift in continuous operation 24 hours each day for a period of four months.

An illustration of the high head against which the air lift can operate is afforded by a mine in the Rocky Mountain section. The pump takes air from a high-pressure compressed-air locomotive service main, and lifts 160 gallons of water per minute more than 700 feet vertically. The air is delivered to the eduction pipe through a 5-32 inch round hole drilled in a solid plug cock.

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*"Coal Age," Volume 5, pg. 121.

WATER PIPES

The varieties of pipe used in mines are: (1) cast iron, (2) wrought iron, (3) steel, (4) spiral-riveted galvanized, and (5) wood.

Cast Iron

This was the earliest in use, being for a long time the standard in English mining practice, and is, in fact, extensively used there to-day. The usual length of pipe employed is nine feet, with lengths of six feet and three feet for filling in. Cast iron pipe was almost universally used until the manufacture of wrought iron and steel pipe was begun. These proved cheaper, easier to handle, and have the added advantage that they can be cut to any desired length. For the purpose of carrying water in ditches, cast-iron pipe, with ball and spigot joint is still the most widely used type because of its durability. Extra-heavy cast iron for column mains in shafts and slopes is extensively used in mines where the water is heavily charged with acid. They are also largely used in the preparation of coals for carrying water to the shaker screens and jigs.

As compared with wrought iron and steel, cast iron pipes are the most resistant to corrosion. This is ascribed by some metallurgists to the large proportion of graphitic carbon, while others contend that this property is due to an outer skin of a silicate of iron formed in casting. The fact is that there is little or no difference in the readiness with which any of the three are attacked, though there is, undoubtedly, great difference in the rate at which corrosion proceeds, once it has begun. The explanation of this may lie in the granular, or crystalline, structure of cast iron, which, in combination with the chemical, or electro-chemical, action taking place on the surface of the metal serves to arrest the process of corrosion after it has proceeded to a certain depth, through the interposition of ferrous oxide as a permanent, oxygen-excluding, protective coating. Cast-iron pipe shows, when removed after long service, a closely adhering rust coat on the surface which undoubtedly tends to aid in the preservation of the pipe.

Wrought Iron and Steel

Welded wrought-iron pipe has been made in this country for about 65 years, and welded steel pipe for about 30 years. Owing to the lower cost of producing steel—usually 20 to 40 per cent. less than wrought iron—steel pipe readily supplanted wrought iron. There is no question that initially the tensile strength of steel pipe exceeds that of wrought iron and that it will therefore stand a higher pressure before failure. Water lines in mines, however, fail largely because of the corrosive action of mine water, and here there is considerable difference of opinion as to the rate of deterioration of steel and wrought-iron pipe.

The difference between wrought and steel lies chiefly in the metallurgical processes, with some distinction to be made as to physical structure and as to composition and proportion of the ingredients other than iron. Due to the process of making wrought iron the iron base is interspersed with a multitude of filaments of cinder, giving a fibrous appearance to the whole structure. The cinder is non-corrosive to weak acids, such as are usually encountered in mines. Rust, therefore, can only destroy the iron, not the cinder. The amount of cinder varies from four to six per cent. by volume and is sometimes finely disseminated throughout the mass, with a spacing so close as to interfere with the continued attack of moisture and oxygen.

The proposition that cinder is a benefit to wrought iron in resisting corrosion has been much assailed. Those dissenting contend that any superiority of wrought iron would be due to its comparative freedom from impurities, such as manganese, the absence of blow holes, and the presence of phosphorus. Manganese, it is suspected, starts an electrolytic action which hastens the corrosion of steel. But, on the other hand, it is urged that the cinder within the wrought iron likewise causes a difference of potential, and to that extent counteracts some of its good effects by hastening corrosion. The electrolytic theory of the corrosion of iron is now receiving the diligent attention of metallurgists in the hope that means of preserving the metal may be discovered.

In the manufacture of steel, the cinders float to the top, where they are removed. After refining by the Bessemer or open hearth process, the metal is cast into ingots, reheated and rolled into blooms, slabs or billets. One prominent concern uses a roll-knobbling process of working the metal, thereby giving it much additional kneading while hot, thus rendering the structure more dense and resistant to corrosion and pitting.

Numerous tests have been made to substantiate the claims of superiority set forth by the proponents of each class of pipe. Irrespective of the conclusions reached by these investigations, the fact is that every mine is in itself a testing laboratory, and since the test of merit is the test of time and service, every mine official may easily and conclusively determine for himself which class of pipe gives the most service per dollar of expenditure. In making such a test an accurate account should be kept of all labor costs involved from the time the pipe is received at the mine until it is in place, and to this is added the material cost of each kind of pipe. In this way the total cost of each kind of installation will be known and a basis furnished for comparison.

The corrosion of iron and steel involves several variables, and quite generally there is such a delicate balance between the forces at work that apparently minor differences in some of the conditions of test may cause quite marked variations from the results of experience. Test installations should, therefore, conform as closely as possible to the conditions of intended service.

General directions for conduct of tests in the mine or under service conditions are as follows:

1. Installation of lengths of the various kinds of pipe (the more of each the better) in an actual service line. If several lengths of each, have them alternating in the line.

2. Preferably test each piece to destruction, noting the time, and replacing each pipe which fails with another, without taking down the whole line at the failure of the first pipe. End effects are to be neglected because of probable electrolytic influence at the junction of dissimilar materials. Testing to failure is better than judging conditions after a stated interval of service, since corrosion does not proceed in the different materials at a fixed time-depth rate.

3. Get data on enough pipe of each character, preferably by repeating tests, so that the verdict is above question. Such a verdict may be possible in a single test; usually it requires a number.

4. Be careful that conditions are comparable throughout the test line. Location near a sump or pump may be more severe than farther away; availability of oxygen is a most important factor in corrosion. Such a condition may be neutralized by a judicious distribution of pipes in a single test, or by rotation of arrangement in a series of tests.

Spiral Galvanized Pipe

This style of pipe is used by many companies for delivery mains where the water is comparatively free from acid. It is made of sheet- steel plates, placed spirally, and having the lap riveted. Its carrying capacity is from 10 to 15 per cent. less than cast iron, owing to increased friction due to the lips and rivets. Its lightness, as compared with other metal pipes, is much in its favor.

Wood Pipes

Wood pipe has been manufactured up to 86 inches in diameter, and to withstand pressures up to 200 lbs. per square inch. The larger sizes are made from staves of uniform width and thickness, with beads left on one edge and correspondingly placed grooves on the other. The staves are bound together and strengthened by bands, coated with pitch for protection against corrosion. The smaller sizes of pipe are bored from solid logs.

Wood pipe is entirely immune from the ravages of both acids and electrolysis and is claimed to be as durable as cast iron, and more durable than wrought iron and steel. It is cheaper than any of the metals and has lightness in weight, ease of handling, and low cost of transportation in its favor. The coefficient of friction of wood pipe is low, and since the interior wears smooth, it remains low, unlike metal pipe, where, because of incrustation, the coefficient of friction rises after the pipe is in use.

In mining practice wood pipe is used for delivery mains, to carry water to reservoirs and for town supply, for use in washers, jigs, flushing, etc.

Reinforced Concrete Pipe

Reinforced concrete pipe is coming into general use for drainage purposes and low pressure water mains. It is made in bell and spigot type, reinforced with rods circularly bent, continuous spirals, or triangular mesh. It can be obtained in sizes ranging up to 96 inches in diameter, and in lengths of 4, 6 and 8 feet. An extra heavy grade is manufactured for use under railroad tracks and has been adopted in place of cast iron for culvert purposes by many of the leading railroads, notably those operating through coal districts. When made with a hard,

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*See Tech. Paper No. 15, Bureau of Mines, "An Electrolytis Method of Preventing Corrosion of Iron and Steel."

silicious aggregate, it is acid proof and forms a very desirable medium for the discharge of mine sulphur water.

Lined Pipes

Column mains may be protected from acid waters in the same way as water cylinders, and wood-lined cast-iron pipes for conducting water or slush are in use. Within recent years cement-lined wrought-iron pipes have been placed on the market. Cast-iron pipes are usually coated by dipping in a hot mixture of coal-tar and coal-tar pitch; riveted steel pipe and ordinary water pipe by dipping in hot asphaltum or the application of some good neutral coating or paint that not only is unaffected by the chemical action of mine water, but also is so compounded as to meet the abrasion of gritty water pumped under heavy pressure.

Installation of Pipe Lines

Whatever kind of water-pipe is selected, it is necessary for the highest efficiency in pumping that the work of installation be well and properly done. A few suggestions may well be in order here. Companion flanges are provided with the pump, calling for a certain size suction and discharge pipe. Do not use a smaller size than called for, rather increase than decrease the size. A smaller pipe means a higher velocity of water travel, and the friction of liquids in pipes increases as the square of velocity. Avoid right angles where possible. Use either a bend with long radius, or two 45 deg. ells with a short nipple between. Put a strainer on the end of the suction line and add a foot valve where the suction line is long or the lift is high. Guard constantly against all leaks in the suction line. Place a check or gate valve on the delivery line. Never use a globe valve on any pump line. If a gate valve is provided instead of a check valve, damage may result to the pump through closure of the valve while the pump is running. To guard against the possible mischief resulting, a pop valve may be fixed on the main, being set at a point somewhat above the working pressure. Keep the pump close to the sump so that the travel will be short. Have the discharge column well supported in the shaft by means of iron straps. Use flanged pipe and have the flanges supported at intervals by cross pieces. Have the water delivered away from the mine opening so that none seeps back into the workings.

Water Hoisting

Water hoisting was begun in the anthracite fields, in 1880, at the Nanticoke collieries of the Susquehanna Coal Company, where semi-cylindrical tanks were attached underneath the cages and water hoisted during the night shift. The present method of hoisting from a special water shaft, or water compartment, was first used at the Luke Fidler colliery in 1896 to unwater the mine, which had been flooded to subdue a mine fire.

A large number of water hoists are now in use, not only in the coal fields of the eastern United States, but in the metalliferous mines of the West as well. There are many great advantages in hoisting water, particularly from deep shafts;* (1) the simplicity of the construction; (2) having all the operating machinery on the surface, with the resulting low cost of repairs, which are practically confined to tanks and ropes, (3) the almost total absence of slip, which under mining conditions reduces materially, from the quantity calculated from plunger displacement, the actual quantity of water pumped; (4) the avoidance of underground steam lines, with their large condensation losses, damage to roof and timbering from the heat and exhaust steam and the danger of fire incident to their use; (5) the almost total freedom from danger of falls or squeezes in the mine; and (6) most important of all, because the operating plant cannot be flooded.

The disadvantage in steam driven hoists is that difficulty is met with in using steam expansively. Hoisting is done at high speeds and the time consumed in accelerating the load, during which steam is admitted at full stroke, together with the retarding period, when the excess power is wasted by the application of the brakes, makes the system wasteful of fuel. Considered solely from the standpoint of duty, it is doubtful whether water hoists have any economic advantage over pumping at depths within the proper lift of one pump.

Electricity has to some extent supplanted steam as the motive power. One of the water hoists of the Delaware, Lackawanna and Western Railroad Company† uses a motor running continuously in one direction, as it is a well known fact that the amount of current required to accelerate a large motor is enormous. Reversing the load is accomplished by the use of friction clutches, a method which had already proven successful in the operation of similar hoists.

The cost of sinking the shaft, erecting head frame and sheaves, installing the hoisting machinery, boilers, foundations, ropes, guides, etc., is large and reflects the tremendous cost of handling water to the industry. Thus, the William Penn water hoist (anthracite) having a depth of shaft of 953 feet and capacity of tanks 1440 gallons, cost $46,600, while the Lytle water hoist, depth of shaft 1500 feet and capacity of tanks 2600 gallons, cost more than $80,000.

In the pottsville region tanks holding 3000 gallons (11 tons) are in use, and in the Northern Anthracite fields, near Scranton, are mines where tanks are used in which 5100 gallons (18.8 tons) are hoisted each minute. Water hoists have been succesfully used to unwater abandoned workings in the McAlester coal fields in Oklahoma,‡ and for emergency use when the steam driven pump failed owing to valve troubles at the Coleman shaft, Cambria county, Pennsylvania.§

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*From Trans. A. I. M. E. Vol. 34, "Water Hoisting in Anthracite Regions," by H. V. Norris.

†Mines and Minerals, Vol. 26, pg. 205.

‡Coal Age, Vol. 3, pg. 989.

§Mines and Minerals, Vol. 31, pg. 631.

NOTE—We are indebted to the following manufacturers for cuts and illustrations appearing in this article:

Allis-Chalmers Manufacturing Company,
American Steam Pump Company,
A. S. Cameron Steam Pump Works,
The Deming Company,
Epping-Carpenter Pump Company,
Goulds Manufacturing Company,
Ingersoll-Rand Company,
International Steam Pump Company,
Morris Machine Works,
Pulsometer Steam Pump Company,
Wagener Steam Pump Company,
Sullivan Machinery Company.

WHEN ORDERING PUMPS

Manufacturer wants to know:—

How many gallons you want to handle per minute.

The amount of suction lift, length and size of suction pipes. If you want to use one or more branches to suction. So state.

The amount of discharge lift. Length and size of discharge pipe. If other pumps use same discharge line, so state, giving approximate quantity of water passing through line.

Will the water contain any solids? Give character of water and state preference as to metal to be used in water end of pump.

If steam is to be used, give boiler pressure, length, size and condition of steam line and probable pressure at the pump.

If compressed air is to be used, give air pressure at the pump.

If electricity is to be used, give voltage and state alternating or direct current. If alternating, state if single phase, two or three phase, the voltage and number of cycles. Does voltage vary materially?

Courtesy Harris Pump & Supply Co.

To Select Proper Size Motor for Your Pump

Remember that feet elevation given in table includes three distinct elevations. First. Actual difference in elevation of water to be pumped at its lowest point and highest point to which water is elevated. Second. The equivalent of vertical feet necessary to overcome the friction caused by water handled in passing through all the line, including suction and discharge lines, the pump itself and all obstructions, including elbows, bends and gate valves. See Table for friction of water in pipes. Figure five elbows the same as 100 fet of straight pipe. Use gate valves instead of globe valve for water wherever possible. Use swing checks instead of poppet checks. Third. Velocity heads. This is usually so small in mine srvice as to be neglected in calculations.

To find horse-power required for a piston power pump, multiply theoretical horse-power shown in table by 1½ to 2. For triplex pumps up to 100 feet multiply by 1½ to 2. For elevations 100 to 200 feet—1½; for elevations 200 to 400 feet, multiply by 1.4.

For deep well pumps, multiply by 2 to 3.

For centrifugal pumps, multiply by 2 to 2½.

In centrifugal pumps remember that the speed of motor and pump should be right for the elevation and when speeded too high or put on a lower elevation, more water will be pumped and much more power required.

TABLE OF CAPACITY OF PUMPS

The figures at the extreme right and left of the Table are plunger or piston diameters; the line of figures across the top are length of plunger or piston strokes; the figures in the body of the Table are the capacity, or displacement in U. S. gallons, corresponding to a single stroke. To find the capacity for one revolution, multiply the capacity for a single stroke by one, two, three, four or five, for single, duplex, triplex, quadruplex or quintuplex, single-acting; and by two, four, six, eight or ten, for double-acting pumps.

Diameter of Plunger Inches	Length of Stroke in Inches, and Capacity per Stroke in U. S. Gallons, of Pump Cylinder, with Given Diameter																	Diameter of Plunger Inches
	1	4	5	6	7	8	9	10	12	14	16	18	20	24	30	36	48	
1¼	.0053	.0212	.0266	.0319	.0372	.0425	.0478	.0531	.0637	.0743	.0848	.0955	.1062	.1274	.1590	.1908	.2544	1¼
1⅜	.0064	.0256	.0321	.0385	.0419	.0513	.0578	.0642	.077	.089	.1027	.1156	.1280	.1541	.1920	.2304	.3072	1⅜
1½	.00765	.0306	.0382	.0459	.0535	.0612	.0688	.0765	.0918	.1071	.1224	.1377	.1530	.1836	.2295	.2754	.3672	1½
1¾	.0104	.0416	.0521	.0625	.0729	.0833	.0937	.1041	.1249	.1457	.1666	.1874	.2082	.2499	.3120	.3744	.4992	1¾
2	.0136	.0544	.068	.0816	.0952	.1088	.1224	.136	.1632	.1904	.2176	.2448	.2720	.3264	.4080	.4896	.6528	2
2¼	.0172	.0688	.086	.1033	.1205	.1377	.1548	.1721	.2063	.241	.2754	.3096	.344	.4128	.5160	.6192	.8256	2¼
2½	.02125	.0850	.1062	.1275	.1487	.17	.1912	.2125	.255	.2975	.34	.3825	.4252	.51	.6375	.7650	1.0200	2½
2¾	.0257	.1028	.1285	.1543	.1799	.2057	.2313	.2571	.3085	.3598	.4114	.4626	.5142	.617	.7710	.9252	1.2336	2¾
3	.0306	.1224	.1530	.1836	.2142	.2448	.2754	.306	.3672	.4284	.4896	.5508	.612	.7344	.9180	1.1016	1.4688	3
3¼	.0359	.1436	.1795	.2154	.2513	.2872	.3231	.3594	.4312	.503	.5748	.6466	.7182	.8624	1.0770	1.2924	1.7232	3¼
3½	.04165	.1666	.2082	.2499	.2915	.3332	.3748	.4165	.4998	.5831	.6664	.7497	.833	.9996	1.2495	1.4994	1.9992	3½
3¾	.0478	.1912	.239	.2868	.3346	.3824	.4302	.478	.5736	.6692	.7648	.8605	.9561	1.147	1.4340	1.7208	2.2944	3¾
4	.0544	.2176	.272	.3264	.3808	.4352	.4896	.544	.6528	.7616	.8704	.9792	1.088	1.3050	1.6320	1.9584	2.6112	4
4¼	.0614	.....	.307	.3684	.4298	.4912	.5526	.6141	.7368	.8596	.9824	1.105	1.228	1.473	1.8420	2.2104	2.9472	4¼
4½	.06885	.....	.3442	.4131	.4819	.5508	.6196	.6885	.8262	.9639	1.1016	1.2393	1.377	1.6524	2.0655	2.4786	3.3048	4½
4¾	.0767	.....	.3835	.4602	.5369	.6136	.6903	.7671	.9204	1.073	1.227	1.380	1.534	1.84	2.3010	2.7612	3.6816	4¾
5	.0850	.....	.425	.51	.595	.68	.765	.85	1.02	1.19	1.36	1.53	1.7	2.04	2.5500	3.0600	4.0800	5
5¼	.0937	.....	.....	.5622	.6559	.7496	.8433	.9371	1.124	1.311	1.499	1.686	1.874	2.248	2.8110	3.3732	4.4976	5¼
5½	.10285	.....	.....	.6171	.7199	.8228	.9256	1.0285	1.2342	1.4399	1.6456	1.8513	2.057	2.4684	3.0855	3.7026	4.9368	5½
5¾	.1124	.....	.....	.6744	.7868	.8992	1.011	1.124	1.348	1.573	1.789	2.022	2.248	2.696	3.3720	4.0464	5.3952	5¾
6	.1224	.....	.....	.7314	.8568	.9792	1.1016	1.2240	1.4688	1.7136	1.9584	2.2032	2.448	2.9376	3.6720	4.4064	5.8752	6
6¼	.1328	.....	.....	.7968	.9296	1.062	1.195	1.328	1.593	1.859	2.124	2.39	2.656	3.186	3.9840	4.7808	6.3744	6¼
6½	.1436	.....	.....	.8610	1.0052	1.1488	1.2926	1.4364	1.724	2.0109	2.2982	2.5885	2.8728	3.4473	4.3080	5.1696	6.8928	6½
6¾	.1549	.....	.....	.9294	1.084	1.239	1.394	1.549	1.858	2.168	2.479	2,788	3.098	3.716	4.6470	5.5764	7.4352	6¾
7	.1666	.....	.....	.9996	1.1662	1.3328	1.4994	1.666	1.9992	2.3324	2.6656	2.9988	3.332	3.9984	4.9980	5.9976	7.9968	7
7¾	.2042	.....	.....	1.225	1.429	1.633	1.837	2.042	2.45	2.858	3.266	3.674	4.084	4.9	6.1260	7.3512	9.8016	7¾
8	.2176	.....	.....	1.3056	1.5232	1.7408	1.9584	2.176	2.6112	3.0464	3.4816	3.9168	4.352	5.2224	6.5280	7.8336	10.4448	8
9	.2754	.....	.....	......	1.9278	2.2032	2.4786	2.754	3.3048	3.8556	4.4064	5.0572	5.508	6.6096	8.2620	9.9144	13.2192	9
10	.3400	.....	.....	......	......	2.72	3.06	3.4	4.08	4.76	5.44	6.12	6.8	8.16	10.20	12.2400	16.3200	10
11	.41135	.....	.....	......	......	......	3.7258	4.1139	4.9367	5.7595	6.5823	7.4051	8.2279	9.8735	12.34	14.8086	19.7448	11
12	.4896	.....	.....	......	......	......	......	4.896	5.8752	6.8544	7.833	8.8128	9.792	11.7504	14.688	17.6256	23.5008	12
13	.5745	.....	.....	......	......	......	......	......	6.894	8.042	9.192	10.34	11.49	13.78	17.235	20.6820	27.5760	13
14	.6660	.....	.....	......	......	......	......	......	7.994	9.328	10.66	11.99	13.32	15.98	19.98	23.9760	31.968	14
15	.7645	.....	.....	......	......	......	......	......	......	10.70	12.23	13.76	15.29	18.35	22.935	27.5220	36.696	15
16	.8700	.....	.....	......	......	......	......	......	......	12.18	13.92	15.66	17.40	20.88	26.10	31.3200	41.760	16
18	1.1010	.....	.....	......	......	......	......	......	......	....	17.61	19.81	22.02	26.42	33.03	39.636	52.848	18
20	1.3600	.....	.....	......	......	......	......	......	......	....	21.76	24.48	27.2	32.64	40.80	48.96	65.280	20

Courtesy of The Aldrich Pump Co.

Capacities of Single-Acting Triplex Pumps

Dia. of Plunger in Inches	Length of Stroke in inches, and Capacity per Revolution in U. S. Gallons, of Single-Acting Triplex Pump with given Diameter																Dia. of Plunger in Inches
	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	24	
1	.0102	.020	.030	.040	.051	.061	.071	.082	.092	.102	.122	143	.163	.184	.204	.244	1
1¼	.0159	.031	.047	.063	.079	095	.111	.127	.143	159	.191	.223	.254	.286	.318	.382	1¼
1½	.0229	.045	.069	.091	.114	.137	.161	.184	.206	.229	.275	.322	.367	.413	.459	.551	1½
2	.0408	.081	.122	.163	.204	.244	.285	.326	.367	.408	.489	.571	.653	.735	.816	.979	2
2½	.0637	.127	.191	.255	.318	.382	.447	510	574	.637	.765	.894	1.02	1.15	1.27	1.53	2½
3	.0918	.183	.276	.367	.459	.550	.642	.734	.826	918	1.10	1.28	1.47	1.65	1.83	2.20	3
3½	.1249	.249	.374	.498	.629	.749	.875	998	1.12	1.25	1.49	1.75	2.00	2.24	2.50	3.00	3½
4	.1632	.326	.489	.652	.816	.980	1.14	1.31	1.47	1.63	1.96	2.28	2.62	2.94	3.27	3.92	4
4½	.2065	.413	.619	.826	1.03	1.24	1.44	1.65	1.86	2.06	2.48	2.89	3.30	3.72	4 13	4.96	4½
5	.2550	.510	.765	1.02	1.27	1.53	1.78	2.04	2.30	2.55	3.06	3.57	4.08	4.59	5.10	6.12	5
5½	.3085	.617	.925	1.23	1.54	1.85	2.16	2.47	2.78	3.08	3 70	4.32	4.94	5.55	6.17	7.40	5½
6	.3672	.734	1.10	1,46	1.83	2.20	2.57	2.94	3.30	3.67	4.40	5.13	5.87	6.60	7.35	8.81	6
6½	.4308	.861	1.29	1.72	2.15	2.58	3.02	3.45	3.88	4.31	5 17	6.03	6.89	7.75	8.62	10.34	6½
7	.4998	.999	1.49	1.99	2.49	2.99	3.50	3.99	4.50	5.00	5.98	6.99	7 99	9.00	10.00	11.99	7
7½	.5737	1.14	1.72	2.29	2.86	3.44	4.02	4.58	5.16	5.74	6.88	8.03	9.17	10.32	11.47	13.77	7½
8	.6528	1.30	1.95	2.61	3.26	3.91	4.67	5.22	5.87	6.53	7.83	9.14	10.44	11.74	13.05	15.66	8
8½	.7369	1.47	2.21	2.84	3.68	4.42	5.16	5.90	6.62	7.37	8.84	10.31	11.77	13.24	14.73	17.68	8½
9	.8262	1.65	2.48	3.30	4.13	4.96	5.78	6.61	7.43	8.26	9.91	11.56	13.22	14.87	16.52	19.83	9
9½	.9205	1.84	2.76	3.68	4.60	5.52	6.45	7.36	8.28	9.20	11.04	12.88	14.72	16.57	18.40	22.09	9½
10	1.020	2.04	3.06	4.08	5.10	6.12	7.14	8.16	9.18	10.20	12.24	14.28	16.32	18.36	20.40	24.48	10
11	1.234	2.46	3.70	4.93	6.17	7.40	8.64	9.87	11.10	12.34	14.81	17.28	19.74	22.21	24.68	29.62	11
12	1.468	2.93	4.40	5.87	7.34	8.81	10.28	11.75	13.21	14.69	17 62	20.56	23.50	26.42	29.38	35.25	12
13	1.723	3.44	5.17	6.89	8.61	10.34	12.06	13.78	15.51	17.24	20.68	24.12	27.57	31.02	34.47	41.36	13
14	1.998	3.99	5.99	7.99	9.99	11.98	13.99	15.99	17.99	19.98	23.97	27.97	31 97	35.96	39.96	47.95	14
15	2.293	4.58	6.88	9.17	11.46	13.74	16.05	18.34	20.64	22.94	27.52	32.11	36.79	41.28	45.87	55.04	15
16	2.610	5.22	7.83	10.44	13.05	15.66	18.27	20.88	23.49	26.10	31.32	36.54	41 76	46.98	52.20	62.64	16
17	2.947	5.89	8.84	11.79	14.74	17.69	20.62	23.58	26.53	29.47	35.37	41 25	47 16	53.06	58.95	70.75	17
18	3.303	6.60	9.90	13.21	16.52	19.82	23.12	26.42	29.72	33.03	39.64	46 24	52.85	59.45	66.06	79.27	18
19	3.682	7.36	11.04	14.72	18.41	22.09	25.78	29.46	33.14	36.82	44 19	51.55	58.91	66.28	73.64	88.37	19
20	4.080	8.16	12.24	16.32	20.40	24.48	28.56	32.64	36.72	40.80	48 96	57.12	65 28	73.44	89.76	97.92	20

Note—To find capacity of Single-Acting Quintuplex pumps, multiply results in above table by 5-3.

Courtesy of The Aldrich Pump Co.

FRICTION LOSS IN POUNDS PRESSURE.

Friction loss in pounds pressure per square inch for each 100 foot length in different size clean iron pipe, discharging given quantities per minute.

Gallons per Min.	SIZES OF PIPES—INSIDE DIAMETER.																
	¾ in.	1 in.	1¼ in.	1½ in.	2 in.	2½ in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.	10 in.	12 in.	14 in.	16 in.	18 in.	20 in.
5	3.3	.84	.31	.12	.03	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	13.0	3.16	1.05	.47	.12	.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	28.7	6.98	2.38	.97	.27	.06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	50.4	12.3	4.07	1.66	.42	.13	.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25	78.0	19.0	6.40	2.62	.67	.21	.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	27.5	9.15	3.75	.91	.30	.12	.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
35	.....	37.0	12.4	5.05	1.26	.42	.14	.05	.....	.....	....	.....	.....	.....	.....	.....	.....	.....
40	.....	48.0	16.1	6.52	1.60	.51	.17	.06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
45	.....	.....	20.2	8.15	2.01	.62	.27	.07	.....	.....	.....	.....	.....	....	.....	.....	.....	.....
50	.....	.....	24.9	10.0	2.44	.81	.35	.09	.03	.....	.....	.....	.....	.....	.....	.....	.....	.....
75	.....	.....	56.1	22.4	5.32	1.80	.74	.21	.06	.03	.....	.....	.....	.....	.....	.....	.....	.....
100	.....	.....	.....	39.0	9.46	3.20	1.31	.33	.12	.05	.....	.....	.....	.....	.....	.....	.....	.....
125	.....	.....	.....	.....	14.9	4.89	1.99	.51	.17	.07	.....	.....	.....	.....	.....	.....	.....	.....
150	.....	.....	.....	.....	21.2	7.0	2.85	.69	.25	.10	.....	.02	.....	.....	.....	.....	.....	.....
175	.....	.....	.....	.....	28.1	9.46	3.85	.95	.34	.14	.....	.03	.....	.....	.....	.....	.....	.....
200	.....	.....	.....	.....	37.5	12.47	5.02	1.22	.42	.17	.08	.05	.01	.....	.....	.....	.....	.....
250	.....	.....	.....	.....	.....	19.66	7.76	1.89	.65	.26	.13	.07	.03	.01	.....	.....	.....	.....
300	.....	.....	.....	.....	.....	28.06	11.2	2.66	.93	.37	.18	.09	.04	.....	.....	.....	.....	.....
350	.....	.....	.....	.....	.....	.....	15.2	3.65	1.28	.50	.25	.12	.05	.02	.....	.....	.....	.....
400	.....	.....	.....	.....	.....	.....	19.5	4.73	1.68	.65	.32	.16	.06	.....	.....	.....	.....	.....
450	.....	.....	.....	.....	.....	.....	25.	6.01	2.10	.81	.42	.20	.07	.03	.....	.....	.....	.....
500	.....	.....	.....	.....	.....	.....	30.8	7.43	2.70	.96	.49	.25	.09	.04	.017	.009	.005	.....
600	.....	.....	.....	.....	.....	.....	.....	10.6	3.45	1.72	.86	.348	.13	.05	.24	.....	.....	.....
750	.....	.....	.....	.....	.....	.....	.....	.....	5.40	2.21	1.11	.53	.18	.08	.038	.....	.....	.....
1000	.....	.....	.....	.....	.....	.....	.....	.....	9.60	3.88	1.91	.94	.32	.13	.062	.036	.02	.012
1250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.46	.49	.20	.....	.....	.....	.....
1500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.09	.70	.29	.135	.071	.040	.....
1750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.95	.38	.....	.....	.....	.....
2000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.23	.49	.234	.123	.071	.042
2500	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	.....	.....	.....	.77	.362	.188	.107	.....
3000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.11	.515	.267	.15	.091
3500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.697	.365	.204	.124
4000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.91	.472	.264	.158
4500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.593	.33	.200
5000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.730	.41	.244
*	$\sqrt{5}$	1	1.75	2.76	5.66	9.88	15.59	32	55.9	88.2	129.6	181.	316.2	498.8	733.4	1024	1375	1760

*** Comparative Discharging Power of Pipes**

Remember, **doubling** the quantity of water forced through a line **doubles** the **velocity** and makes **four times the friction.**
In figuring friction of water in elbows, assume five ordinary elbows the equivalent of 100 feet of straight pipe.
One pound of pressure is the same as the pressure of water 2.3 feet high.

Theoretical Horse Power Required to Raise Water to Different Heights.

Feet Elevation Gallons per Min.	5	10	15	20	25	30	35	40	45	50	60
5	.006	.012	.019	.025	.031	.037	.044	.05	.06	.06	.07
10	.012	.025	.037	.050	.062	.075	.087	.10	.11	.12	.15
15	.019	.037	.056	.075	.094	.112	.131	.15	.17	.19	.22
20	.025	.050	.075	.100	.125	.150	.175	.20	.22	.25	.30
25	.031	.062	.093	.125	.156	.187	.219	.25	.28	.31	.37
30	.037	.075	.112	.150	.187	.225	.262	.30	.34	.37	.45
35	.043	.087	.131	.175	.219	.262	.306	.35	.39	.44	.52
40	.050	.100	.150	.200	.250	.300	.350	.40	.45	.50	.60
45	.056	.112	.168	.225	.281	.337	.394	.45	.51	.56	.67
50	.062	.125	.187	.250	.312	.375	.437	.50	.56	.62	.75
60	.075	.150	.225	.300	.375	.450	.525	.60	.67	.75	.90
75	.093	.187	.281	.375	.469	.562	.656	.75	.84	.94	1.12
90	.112	.225	.337	.450	.562	.675	.787	.90	1.01	1.12	1.35
100	.125	.250	.375	.500	.625	.750	.875	1.00	1.12	1.25	1.50
125	.156	.312	.469	.625	.781	.937	1.094	1.25	1.41	1.56	1.87
150	.187	.375	.562	.750	.937	1.125	1.312	1.50	1.69	1.87	2.25
175	.219	.437	.656	.875	1.093	1.312	1.531	1.75	1.97	2.19	2.62
200	.250	.500	.750	1.000	1.250	1.500	1.750	2.00	2.25	2.50	3.00
250	.312	.625	.937	1.250	1.562	1.875	2.187	2.50	2.81	3.12	3.75
300	.375	.750	1.125	1.500	1.875	2.250	2.625	3.00	3.37	3.75	4.50
350	.437	.875	1.312	1.750	2.187	2.625	3.062	3.50	3.94	4.37	5.25
400	.500	1.000	1.500	2.000	2.500	3.000	3.500	4.00	4.50	5.00	6.00
500	.625	1.250	1.875	2.500	3.125	3.750	4.375	5.00	5.62	6.25	7.50

Feet Elevation Gallons per Min.	75	90	100	125	150	175	200	250	300	350	400
5	.09	.11	.12	.16	19	.22	.25	.31	.37	.44	.50
10	.19	.22	.25	.31	.37	.44	.50	.62	.75	.87	1.00
15	.28	.34	.37	.47	.56	.66	.75	.94	1.12	1.31	1.50
20	.37	.45	.50	.62	.75	.87	1.00	1.25	1.50	1.75	2.00
25	.47	.56	.62	.78	.94	1.09	1.25	1.56	1.87	2.19	2.50
30	.56	.67	.75	.94	1.12	1.31	1.50	1.87	2.25	2.62	3.00
35	.66	.79	.87	1.08	1.31	1.53	1.75	2.19	2.62	3.06	3.50
40	.75	.90	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00
45	.84	1.01	1 12	1.41	1.69	1.97	2.25	2.81	3.37	3.94	4.50
50	.94	1.12	1.25	1.56	1.87	2.19	2.50	3.12	3.75	4.37	5.00
60	1.12	1.35	1.50	1.87	2.25	2.62	3.00	3.75	4.50	5.25	6.00
75	1.40	1.69	1.87	2.34	2.81	3.28	3.75	4.69	5.62	6.56	7.50
90	1.68	2.02	2.25	2.81	3.37	3.94	4.50	5.62	6.75	7.87	9.00
100	1.87	2.25	2.50	3.12	3.75	4.37	5.00	6 25	7.50	8.75	10.00
125	2.34	2.81	3.12	3.91	4.69	5.47	6.25	7.81	9.37	10.94	12.50
150	2.81	3.37	3.75	4.69	5.62	6.56	7.50	9.37	11.25	13.12	15.00
175	3.28	3.94	4.37	5.47	6.56	7.66	8.75	10.94	13.12	15.31	17.50
200	3.75	4.50	5.00	6.25	7.50	8.75	10.00	12.50	15.00	17.50	20.00
250	4.69	5.62	6.25	7.81	9.37	10.94	12.50	15.72	18.75	21.87	25.00
300	5.62	6.75	7.50	9.37	11.25	13.12	15.00	18.75	22.50	26.25	30.00
350	6.56	7.87	8.75	10.94	13.12	15.31	17.50	21.87	26.25	30.62	35.00
400	7.50	9.00	10.00	12.50	15.00	17.50	20.00	25.00	30.00	35.00	40.00
500	9.37	11.25	12.50	15.62	18.75	21.87	25.00	31.25	37.50	43.75	50.00

The theoretical horse power required to elevate water is found by multiplying the gallons pumped per minute by the total lift (including friction) in feet, and dividing by 4000. To get the actual horse power required, divide the theoretical power obtained from the table above by the efficiency of the pump expressed as a decimal.

Strokes for Piston Speed of 100 Feet per Minute

Length of Stroke Inches	Number of Strokes	Length of Stroke Inches	Number of Strokes	Length of Stroke Inches	Number of Strokes
4	300	12	100	24	50
5	240	14	86	26	46
6	200	16	75	28	43
7	172	18	67	30	40
8	150	20	60	36	33
10	120	22	55	40	30

Relative Quantities of Water

Delivered in 24 Hours, in 1 Hour, and in 1 Minute.

Gallons in 24 hours	Gallons in 1 hour	Gallons in 1 min.	Gallons in 24 hours	Gallons in 1 hour	Gallons in 1 min.	Gallons in 24 hours	Gallons in 1 hour	Gallons in 1 min.
2500000	104166.0	1736.0	650000	27083.3	451.3	150000	6250.0	104.1
2000000	83333.3	1388.0	600000	25000.0	416.7	100000	4166.6	69.4
1500000	62500.0	1041.7	550000	22916.6	381.9	75000	3125.0	52.9
1000000	41666.6	694.3	500000	20833.3	347.2	60000	2500.0	41.6
950000	39583.3	659.7	450000	18750 0	312 5	50000	2083.3	34.7
900000	37500.0	625.0	400000	16666.6	277.7	25000	1041.6	17.3
850000	35416.6	590.2	350000	14583.3	243.0	20000	833.3	13.8
800000	33333.3	555.5	300000	12500.0	208.3	15000	625.0	10.4
750000	31250.0	520.8	250000	10416.7	173.6	10000	416.6	6.9
700000	29166.6	486.1	200000	8833.3	138.8	5000	208.3	3.4

Courtesy of The Deming Company.

The mean pressure of the atmosphere is usually estimated at 14.7 pounds per square inch, so that with a perfect vacuum it will sustain a column of mercury 29.9 inches, or a column of water 33.9 feet high at sea level.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434. Approximately, we say that every foot elevation is equal to ½ pound pressure per square inch; this allows for ordinary friction.

To find the diameter of a pump cylinder to move a given quantity of water per minute (100 feet of piston being the standard of speed), divide the number of gallons by 4, then extract the square root, and the product will be the diameter in inches of the pump cylinder.

To find quantity of water elevated in one minute running at 100 feet of piston speed per minute: Square the diameter of the water cylinder in inches and multiply by 4. Example: Capacity of a 5-inch cylinder is desired. The square of the diameter (5 inches) is 25, which, multiplied by 4, gives 100, the number of gallons per minute (approximately).

To find the horse power necessary to elevate water to a given height, multiply the weight of the water elevated per minute in pounds by the hight in feet, and divide the product by 33,000 (an allowance should be added for water friction, and a further allowance for loss in steam cylinder, say from 20 to 30 per cent).

The area of the steam piston, multiplied by the steam pressure, gives the total amount of pressure that can be exerted. **The area of the water piston,** multiplied by the pressure of water per square inch, gives the resistance. **A margin** must be made between the **power** and the **resistance** to **move** the pistons at the required speed—say from 20 to 40 per cent., according to speed and other conditions.

To find the capacity of a cylinder in gallons. Multiplying the area in inches by the length of stroke in inches will give the total number of cubic inches; divide this amount by 231 (which is the cubical contents of a U. S. gallon in inches), and product is the capacity in gallons.

$$\text{Theoretical Water Horse Power} = \frac{\text{U S. gallons per minute x head in feet.}}{\text{3970 (4000 approx.).}}$$

$$\text{Theoretical Water Horse Power} = \frac{\text{U. S. gallons per minute x head in pounds.}}{\text{1720.}}$$

$$\text{Brake Horse Power} = \frac{\text{Theoretical Water Horse Power.}}{\text{Pump efficiency.}}$$

1,000,000 U. S. gallons per day = 695 U. S. gallons per minute.
500 pounds per hour = 1 U. S. gallon per minute.

1 Miner's inch = 1½ cubic feet per minute = 11.25 U. S. gallons per minute.
1 Cubic foot fresh water = 62.4 lbs. @ 53° F. = 7.48 U. S. gallons.
1 Cubic foot sea water = 64.3 lbs. approx.
1 U. S. gallon fresh water = 8.33 lbs. @ 53° F. = .1134 cubic feet.
1,000 Boiler Horse Power @ 30 pounds feed = 60 gallons per minute (approx.).

$$\text{Velocity in feet per second} = \frac{\text{.41 x U. S. gallons per minute.}}{\text{(diameter of pipe in inches)}}$$

One Acre-foot = 325,850 U. S. gallons.

The Cost of Pumping

The cost (in dollars) per month (30 days of 24 hours each) of pumping 100 U. S. gallons per minute against 1 ft. lift—the efficiency of Pump and Motor together and the cost of Power being known.

RATE	COST		COMBINED EFFICIENCY—MOTOR AND PUMP—PER CENT.												
(Cents) Kw. Hr.	(Cents) H. P. Hour	(Dollars) H. P. Year	40	45	50	55	60	65	70	73	76	80	83	86	90
			Cost per month (30 days—24 hours each) 100 U. S. Gallons per minute against 1 ft. Lift												
0.1	.0007	6.54	.034	.030	.027	.025	.023	.021	.019	.019	.018	.017	.016	.016	.015
0.2	.0015	13.07	.068	.060	.054	.049	.045	.042	.039	.037	.036	.034	.033	.032	.030
0.3	.0022	19.61	.102	.091	.082	.074	.068	.063	.058	.056	.054	.051	.049	.047	.045
0.4	.0030	26.14	.136	.121	.109	.099	.091	.084	.078	.074	.072	.068	.065	.063	.060
0.5	.0037	32.68	.170	.151	.136	.123	.113	.104	.097	.093	.089	.085	.082	.079	.075
0.6	.0045	39.21	.204	.181	.163	.148	.136	.125	.116	.112	.107	.102	.098	.095	.091
0.7	.0052	45.75	.238	.211	.190	.173	.158	.146	.136	.130	.125	.119	.115	.111	.106
0.8	.0060	52.28	.272	.241	.217	.198	.181	.167	.155	.149	.143	.136	.131	.126	.121
0.9	.0067	58.82	.305	.272	.244	.222	.204	.188	.175	.167	.161	.153	.147	.142	.136
1.0	.0075	65.35	.339	.302	.272	.247	.226	.209	.194	.186	.179	.170	.164	.158	.151
1.1	.0082	71.89	.373	.332	.299	.272	.249	.230	.213	.205	.197	.187	.180	.174	.167
1.2	.0090	78.42	.407	.362	.326	.296	.272	.251	.233	.223	.214	.204	.196	.189	.181
1.3	0097	84.96	441	.392	.353	.321	.294	.272	.252	.242	.232	.221	.213	.205	.196
1.4	.0104	91.49	.475	.422	.380	.346	.317	.292	.272	.260	.250	.238	.229	.221	.211
1.5	.0112	98.02	.509	.453	.407	.370	.339	.313	.291	.279	.268	.255	.245	.237	.226
1.6	.0119	104.56	.543	.483	.434	.395	.362	.334	.310	.298	.286	.271	.262	.253	.241
1.7	.0127	111.09	.577	.513	.462	.420	.385	.355	.330	.316	.304	.288	.278	.268	.256
1.8	.0134	117.63	.611	.543	.489	.444	.407	.376	.349	.335	.322	.305	.294	.284	.272
1.9	.0142	124.16	.645	.573	.516	.469	.430	.397	.368	.353	.339	.322	.311	.300	.287
2.0	.0149	130.70	.679	.603	.543	.494	.453	.418	.388	.372	.357	.339	.327	.316	.302
2.1	.0157	137.23	.713	.633	.570	.518	.475	.439	.407	.391	.375	.356	.343	.332	.317
2.2	.0164	143.77	.747	.664	.597	.543	.498	.459	.427	.409	.393	.373	.360	.347	.332
2.3	.0172	150.30	.781	.694	.624	.568	.520	.480	.446	.428	.411	.390	.376	.363	.347
2.4	.0179	156.84	.814	.724	.652	.592	.543	.501	.465	.446	.429	.407	.393	.379	.362
2.5	.0187	163.37	.848	.754	.679	.617	.566	.522	.485	.465	.447	.424	.409	.395	.377
2.6	.0194	169.91	.882	.784	.706	.642	.588	.543	504	.484	.464	.441	.425	.410	.392
2.7	.0201	176.44	.916	.814	.733	.666	.611	.564	.524	.502	.482	.458	.442	.426	.407
2.8	.0209	182.98	.950	.845	.760	.691	.633	.585	.543	.521	.500	.475	.458	.442	.422
2.9	.0216	189.51	.984	.875	.787	.716	.656	.606	.562	.539	.518	.492	.474	.458	437
3.0	.0224	196.05	1.018	.905	.814	.740	.679	.627	.582	.558	.536	.509	.491	.474	.453
3.1	.0231	202.58	1.052	.935	.842	.765	.701	.647	.601	.576	.554	.525	.507	.489	.468
3.2	.0239	209.12	1.086	.965	.869	.790	.724	.668	.621	.595	.572	.543	.523	.505	.483
3.3	.0246	215.65	1.120	.995	.896	.814	.747	.689	.640	.614	.589	.560	.540	.520	.498
3.4	.0254	222.19	1.154	1.025	.923	.839	.769	.710	.659	.632	.607	.577	.556	.536	.513
3.5	.0261	228.72	1.188	1.056	.950	.864	.792	.731	.679	.651	.625	.594	.572	.552	.528
3.6	.0269	235.26	1.222	1.086	.977	.888	.814	.752	.698	.669	.643	.611	.589	.568	.543
3.7	.0276	241.79	1.256	1.116	1.004	.913	.837	.773	.717	.688	.661	.628	.605	.583	.558
3.8	.0283	248.33	1.289	1.146	1.032	.938	.860	.794	.737	.707	.679	.645	.621	.599	.573
3.9	.0291	254.86	1.323	1.176	1.059	.963	.882	.814	.756	725	.697	.662	.638	.615	.588
4.0	.0298	261.40	1.357	1.206	1.086	.987	.905	.835	.776	.744	.714	.679	.654	.631	.603
4.1	.0306	267.93	1.391	1.237	1.113	1.012	.928	.856	.795	.762	.732	.696	.671	.647	.618
4.2	.0313	274.47	1.425	1.267	1.140	1.037	.950	.877	.814	.781	.750	.713	.687	.663	.633
4.3	.0321	281.00	1.459	1.297	1.167	1.061	.973	.898	.834	.800	.768	.730	.703	.679	.649
4.4	.0328	287.54	1.493	1.327	1.194	1 086	.995	.919	.853	.818	.786	.747	.720	.694	.664
4.5	.0336	294.07	1.527	1.357	1.222	1.111	1.018	.940	.873	.837	.804	.764	.736	.710	.679
4.6	.0343	300.61	1.561	1.388	1.249	1 135	1.041	.961	.892	.855	.822	.780	.752	.726	.694
4.7	.0351	307.14	1.595	1.418	1.276	1.160	1.063	.981	.911	.874	.839	.797	.769	.742	.709
4.8	.0358	313.68	1.629	1.448	1.303	1.185	1.086	1.002	.931	.893	.857	.814	.785	.758	.724
4.9	.0366	320.21	1.663	1.478	1.330	1.209	1.108	1.023	.950	.911	.875	.831	.801	.773	.739
5.0	.0373	326.75	1.697	1.508	1.357	1.234	1.131	1.044	.970	.930	.893	.848	.818	.789	.755

To find the cost per month of Pumping any Quantity per minute against any Lift—Divide the desired number of U. S. Gallons per minute by 100, and multiply the Quotient by the required Lift and then by the value in the table found OPPOSITE the price paid for Power, and UNDER the combined efficiency of Motor and Pump.

Water Head in Feet and Equivalent Pressure in Pounds per Square Inch

Head in Feet	Equival't Pressure in Pounds per sq. in.	Head in Feet	Equival't Pressure in Pounds per sq. in.	Head in Feet	Equival't Pressure in Pounds per sq. in.	Head in Feet	Equival't Pressure in Pounds per sq. in.	Head in Feet	Equivalent Pressure in Pounds per sq. in.
1	0.43	64	27.72	127	55.01	189	81.87	1475	638.68
2	0.86	65	28.15	128	55.44	190	82.30	1500	649.50
3	1.30	66	28.58	129	55.88	191	82.73	1525	660.33
4	1.73	67	29.02	130	56.31	192	83.17	1550	671.15
5	2.16	68	29.45	131	56.74	193	83.60	1575	681.98
6	2.59	69	29.88	132	57.18	194	84.03	1600	692.80
7	3.03	70	30.32	133	57.61	195	84.47	1625	703.63
8	3.46	71	30.75	134	58.04	196	84.90	1650	714.45
9	3.89	72	31.18	135	58.48	197	85.33	1675	725.28
10	4.33	73	31.62	136	58.91	198	85.76	1700	736.10
11	4.76	74	32.05	137	59.34	199	86.20	1725	746.93
12	5.20	75	32.48	138	59.77	200	86.60	1750	757.75
13	5.63	76	32.92	139	60.21	225	97.43	1775	768.58
14	6.06	77	33.35	140	60.64	250	108.25	1800	779.40
15	6.49	78	33.78	141	61.07	275	119.08	1825	790.23
16	6.93	79	34.21	142	61.51	300	129.90	1850	801.05
17	7.36	80	34.65	143	61.94	325	140.73	1875	811.88
18	7.79	81	35.08	144	62.37	350	151.55	1900	822.70
19	8.22	82	35.52	145	62.81	375	162.38	1925	833.53
20	8.66	83	35.95	146	63.24	400	173.20	1950	844.35
21	9.09	84	36.39	147	63.67	425	184.03	1975	855.18
22	9.53	85	36.82	148	64.10	450	194.85	2000	866.00
23	9.96	86	37.25	149	64.54	475	205.68	2025	876.83
24	10.39	87	37.68	150	64.97	500	216.50	2050	887.65
25	10.82	88	38.12	151	65.40	525	227.33	2075	898.48
26	11.26	89	38.55	152	65.84	550	238.15	2100	909.30
27	11.69	90	38.98	153	66.27	575	248.98	2125	920.13
28	12.12	91	39.42	154	66.70	600	259.80	2150	930.95
29	12.55	92	39.85	155	67.14	625	270.63	2175	941.78
30	12.99	93	40.28	156	67.57	650	281.45	2200	952.60
31	13.42	94	40.72	157	68.0	675	292.28	2225	963.43
32	13.86	95	41.15	158	68.43	700	303.10	2250	974.25
33	14.29	96	41.58	159	68.87	725	313.93	2275	985.08
34	14.72	97	42.01	160	69.31	750	324.75	2300	995.90
35	15.16	98	42.45	161	69.74	775	335.58	2325	1006.73
36	15.59	99	42.88	162	70.17	800	346.40	2350	1017.55
37	16.02	100	43.31	163	70.61	825	357.23	2375	1028.38
38	16.45	101	43.75	164	71.04	850	368.05	2400	1039.20
39	16.89	102	44.18	165	71.47	875	378.88	2425	1050.03
40	17.32	103	44.61	166	71.91	900	389.70	2450	1060.85
41	17.75	104	45.05	167	72.34	925	400.53	2475	1071.68
42	18.19	105	45.48	168	72.77	950	411.35	2500	1082.50
43	18.62	106	45.91	169	73.20	975	422.18	2525	1093.33
44	19.05	107	46.34	170	73.64	1000	433.00	2550	1104.15
45	19.49	108	46.78	171	74.07	1025	443.83	2575	1114.98
46	19.92	109	47.21	172	74.50	1050	454.65	2600	1125.80
47	20.35	110	47.64	173	74.94	1075	465.48	2625	1136.63
48	20.79	111	48.08	174	75.37	1100	476.30	2650	1147.45
49	21.22	112	48.51	175	75.80	1125	487.13	2675	1158.28
50	21.65	113	48.94	176	76.23	1150	497.95	2700	1169.10
51	22.09	114	49.38	177	76.67	1175	508.78	2725	1179.93
52	22.52	115	49.81	178	77.10	1200	519.60	2750	1190.75
53	22.95	116	50.24	179	77.53	1225	530.43	2775	1201.58
54	23.39	117	50.68	180	77.97	1250	541.25	2800	1212.40
55	23.82	118	51.11	181	78.40	1275	552.08	2825	1223.23
56	24.26	119	51.54	182	78.84	1300	562.90	2850	1234.05
57	24.69	120	51.98	183	79.27	1325	573.73	2875	1244.88
58	25.12	121	52.41	184	79.70	1350	584.55	2900	1255.70
59	25.55	122	52.84	185	80.14	1375	595.38	2925	1266.53
60	25.99	123	53.28	186	80.57	1400	606.20	2950	1277.35
61	26.42	124	53.71	187	81.0	1425	617.03	2975	1288.18
62	26.85	125	54.15	188	81.43	1450	627.85	3000	1299.00
63	27.29	126	54.58						

Equivalents of Liquid Measures and Weights

Measures and Weights for Comparison	Measure and Weight Equivalents of Items in First Column								
	U. S. Gallon	Imperial Gallon	Cubic Inch	Cubic Foot	Cubic Meter	Liter	Pound	*Vedro	*Pood
U.S. Gal.	1.	.833	231.	.1337	.00378	3.785	8.33	.308	.231
Imp. Gal	1.20	1.	277.27	.1604	.00454	4.542	10	.369	.277
Cu. In...	.0043	.00358	1.	.00057	.000016	.0163	.0358	.00132	.001
Cu. Ft...	7.48	6.235	1728.	1.	.02827	28.312	62.355	2.304	1.728
Cu. Met..	264.17	220.05	61023.	35.319	1.	1000.	2200.54	81.364	61.023
Liter...	.26417	.2200	61.023	.0353	.001	1.	2.2005	.08136	.06102
* Vedro	3.249	2.706	750.1	.4344	.01228	12.29	27.06	1.	.7501
Pood.	4.328	3.607	1000.	.578	.01636	16.381	36.07	1.333	1.
Pound..	.12	.1	27.72	.016	.00045	454	1.	0369	0277

*Vedro and Pood are a Russian measure and weight respectively

Barometric Pressures

(At Different Altitudes, with Equivalent Head of Water and the Vertical Suction Lift of Pumps.)

Altitude	Barometric Pressure	Equivalent Head of Water	Practical Suction Lift of Pumps
Sea Level...	14.70 lbs. per sq. in.	33.95 feet	25 feet
¼ mile (1320 ft.) above sea level	14.02 " "	32.38 "	24 "
½ " (2640 ") " "	13.33 " "	30.79 "	23 "
¾ " (3960 ") " "	12.66 " "	29.24 "	21 "
1 " (5280 ") " "	12.02 " "	27.76 "	20 "
1¼ " (6600 ") " "	11.42 " "	26.38 "	19 "
1½ " (7920 ") " "	10.88 " "	25.13 "	18 "
2 " (10560 ") " "	9.88 " "	22.82 "	17 "

Barometer reading in inches multiplied by 0.4908 equals pressure per sq. in.

Input Horse-Power Necessary at Various Efficiencies

(Pump and Motor Combined)

Water H.P. Desired	Combined Efficiency—Motor and Pump—Per Cent.																	Water H.P. Desired
	40	45	50	55	60	65	70	72	74	76	78	80	82	84	86	88	90	
1	2.5	2.2	2.0	1.8	1.7	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1
2	5.0	4.4	4.0	3.6	3.3	3.1	2.9	2.8	2.7	2.6	2.6	2.5	2.4	2 4	2.3	2.3	2.2	2
3	7.5	6.7	6.0	5.4	5.0	4.5	4.3	4.2	4.1	3.9	3.8	3.8	3.7	3.6	3.5	3.4	3.3	3
4	10.0	8.9	8.0	7.2	6.7	6.2	5.7	5.6	5.4	5.3	5.1	5.0	4.9	4.8	4.7	4.5	4.4	4
5	12.5	11.1	10.0	9.0	8.3	7.7	7.1	6.9	6.8	6.6	6.4	6.3	6.1	6.0	5.8	5.7	5.6	5
10	25.0	22.3	20.0	18.2	16.7	15.4	14.3	13.9	13.5	13.1	12.8	12.5	12.2	11.9	11.6	11.4	11.1	10
20	50.0	44.4	40.0	36.4	33.3	30.8	28.6	27.8	27.0	26.3	25.7	25.0	24.4	23.8	23.3	22.7	22.2	20
30	75.0	66.7	60.0	54.6	50.0	46.2	42.8	41.7	40.6	39.5	38.5	37.5	36.6	35.7	34.9	34.1	33.3	30
40	100.0	88.9	80.0	72.7	66.7	61.6	57.2	55.6	54.1	52.6	51.3	50.0	48.8	47.6	46.5	45.4	44.4	40
50	125.0	111.2	100.0	90.8	83.3	77.0	71.5	69.4	67.6	65.8	64.2	62.5	61.0	59.5	58.2	56.8	55.6	50
60	150.0	133.3	120.0	109.1	100.0	92.3	85.7	83.3	81.1	79.0	76.9	75.0	73.2	71.4	69.8	68.2	66.7	60
70	175.0	155.5	140.0	127.3	116.7	107.7	100.0	97.2	94.6	92.2	89.7	87.5	85.3	83.3	81.4	79.5	77.8	70
80	200.0	177.7	160.0	145.4	133.3	123.1	114.3	111.2	108.2	105.3	102.5	100.0	97.6	95.3	93.1	90.8	88.9	80
90	225.0	200.0	180.0	163.6	150.0	138.5	128.6	125.0	121.6	118.5	115.3	112.5	109.7	107.2	104.6	102.3	100.0	90
100	250.0	222.2	200.0	181.8	166.7	153.7	142.8	138.9	135.1	131.6	128.2	125.0	121.9	119.1	116.3	103.7	111.2	100
125	312.5	277.5	250.0	227.3	208.5	192.3	178.6	173.6	168.8	164.3	160.3	156.2	152.4	148.8	145.3	142.0	138.9	125
150	375.0	333.2	300.0	273.0	250.0	231.0	214.5	208.5	202.7	197.4	192.3	187.5	183.0	178.6	174.4	170.4	166.7	150
175	437.5	338.8	350.0	318.0	291.5	269.0	250.0	243.0	236.7	230.1	224.5	218.5	213.5	208.5	203.5	198.8	194.4	175
200	500.0	444.0	400.0	364.0	333.0	308.0	286.0	278.0	270.0	263.0	257.0	250.0	244.0	238.0	233.0	227.0	222.0	200
225	563.0	500.0	450.0	409.0	375.0	346.0	321.7	313.0	304.0	296.0	288.0	281.0	275.0	268.0	262.0	255.0	250.0	225
250	625.0	556.0	500.0	454.0	417.0	385.0	357.0	347.0	338.0	329.0	321.0	313.0	305.0	298.0	291.0	284.0	278.0	250
300	750.0	667.0	600.0	546.0	500.0	462.0	428.0	417.0	406.0	395.0	385.0	375.0	366.0	357.0	349.0	341.0	333.0	300
350	875.0	778.0	700.0	637.0	583.0	538.0	500.0	487.0	473.0	461.0	448.0	438.0	427.0	417.0	407.0	398.0	389.0	350
400	1000.0	889.0	800.0	727.0	667.0	616.0	572.0	556.0	541.0	527.0	513.0	500.0	488.0	477.0	465.0	454.0	444.0	400
450	1125.0	1000.0	900.0	818.0	750.0	692.0	643.0	625.0	608.0	592.0	577.0	563.0	549.0	536.0	523.0	511.0	500.0	450
500	1250.0	1112.0	1000.0	908.0	833.0	770.0	715.0	694.0	676.0	658.0	641.0	625.0	610.0	595.0	582.0	568.6	556.0	500

Table for Equalizing Pipes

The size of main pipe is given in the column at the left. The number of branches is given in the line on top, and the proper size of branches is given in the body of the table on the line of each main and beneath the desired number of branches.

In commercial sizes the nominal 1¼-inch pipe is generally over-size, often as large as 1⅜. It is safe to call it 1.3 inch, and it is so figured in the table. Exact sizes are given for branch pipes. The designer of the pipe system can thus better select the commercial sizes to be used.

Size of Main Pipe	Number of Branches															Size of Main Pipe
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1	.758	.644	.574	.525	.488	.459	.435	.415	.398	.383	.370	.358	.348	.338	.330	1
1¼	.985	.838	.747	.683	.635	.597	.556	.540	.518	.498	.482	.466	.452	.440	.428	1¼
1½	1.14	.967	.861	.788	.733	.689	.653	.623	.597	.575	.555	.538	.522	.508	.494	1½
2	1.52	1.29	1.15	1.05	.977	.918	.870	.830	796	.766	.740	.717	.696	.677	.660	2
2½	1.89	1.61	1.44	1.31	1.22	1.15	1.09	1.09	.995	.958	.925	.896	.870	.846	.825	2½
3	2.27	1.92	1.72	1.58	1.47	1.38	1.31	1.25	1.19	1.15	1.11	1.08	1.04	1.02	.989	3
3½	2.65	2.26	2.01	1.84	1.71	1.61	1.52	1.45	1.39	1.34	1.30	1.25	1.22	1.18	1.15	3½
4	3.03	2.58	2.30	2.10	1.95	1.84	1.74	1.66	1.59	1.53	1.48	1.43	1.39	1.35	1.32	4
4½	3.41	2.90	2.58	2.36	2.20	2.07	1.96	1.87	1.79	1.72	1.67	1.61	1.57	1.52	1.48	4½
5	3.79	3.22	2.87	2.63	2.44	2.30	2.18	2.08	1.99	1.92	1.85	1.79	1.74	1.69	1.65	5
6	4.55	3.87	3.45	3.15	2.93	2.75	2.61	2.49	2.39	2.30	2.22	2.15	2.09	2.03	1.98	6
7	5.30	4.51	4.02	3.68	3.42	3.21	3.05	2.91	2.79	2.68	2.59	2.51	2.44	2.37	2.31	7
8	6.06	5.16	4.59	4.20	3.91	3.67	3.48	3.32	3.18	3.09	2.96	2.87	2.78	2.71	2.64	8
9	6.82	5.80	5.17	4.73	4.40	4.13	3.92	3.74	3.58	3.45	3.33	3.23	3.13	3.04	2.97	9
10	7.58	6.44	5.74	5.25	4.88	4.59	4.35	4.15	3.98	3.83	3.70	3.59	3.48	3.38	3.30	10
12	9.08	7.73	6.89	6.30	5.86	5.51	5.22	4.98	4.78	4.60	4.44	4.30	4.18	4.06	3.96	12

Courtesy of The Aldrich Pump Co.

Importance of Considering the Friction of Water in Pipes

In estimating the total head against which a given quantity of water is to be delivered particular attention is called to the importance of considering the friction of water in pipes, elbows and valves. In writing for estimates the length and size of suction and discharge pipes, and the number of tees, ells and valves must be given.

The importance of using large enough pipes thereby saving power is illustrated as follows: 500 gallons delivered per minute through a 4-inch pipe (see friction table) means a friction head of 170.53 feet for each 1000 feet of pipe; the same quantity delivered through an 8-inch pipe produces a friction head of but 5.64 feet per each 1000 feet of pipe.

Friction of Water in Wrought and Cast Iron Pipes

Frictional heads at given rates of discharge in clean wrought iron pipe. (Inside Diam.) for each 100 feet of length

U. S. Gal. per Minute	U. S. Gal. per 24 Hours	¾ In. Pipe Friction hd Feet	¾ In. Pipe Friction hd Lbs.	1 In. Pipe Friction hd Feet	1 In. Pipe Friction hd Lbs.	1¼ In. Pipe Friction hd Feet	1¼ In. Pipe Friction hd Lbs.	1½ In. Pipe Friction hd Feet	1½ In. Pipe Friction hd Lbs.	2 In. Pipe Friction hd Feet	2 In. Pipe Friction hd Lbs.	2½ In. Pipe Friction hd Feet	2½ In. Pipe Friction hd Lbs.	3 In. Pipe Friction hd Feet	3 In. Pipe Friction hd Lbs.
5	7200	7.59	3.30	1.93	.84	.71	.31	.27	.12						
10	14400	29.90	13.00	10.26	3.16	2.41	1.05	1.08	.47						
15	21600	66.01	28.70	16.05	6.98	5.47	2.38	2.23	.97						
20	28800	115.92	50.40	28.29	12.30	9.36	4.07	3.81	1.66						
25	36000			43.70	19.00	14.72	6.40	6.02	2.62	1.18	.51				
30	43200			63.25	27.50	21.04	9.15	8.62	3.75	2.09	.91				
35	50400			85.10	37.00	28.52	12.40	11.61	5.05	2.76	1.20				
40	57600			110.40	48.00	37.03	16.10	14.99	6.52	3.68	1.60	1.19	.52		
45	64800					46.46	20.20	18.74	8.15	4.60	2.00	1.49	.65		
50	72000					57.27	24.90	23.00	10.00	5.61	2.44	1.86	.81	.80	.35
75	108000					129.00	56.10	51.52	22.40	12.23	5.32	4.14	1.80	1.70	.74
100	144000							89.70	39.00	21.75	9.46	7.36	3.20	3.01	1.31
125	180000									34.27	14.90	11.24	4.89	4.57	1.99
150	216000									48.76	21.20	16.10	7.00	6.55	2.85
175	252000									64.63	28.10	21.75	9.46	8.85	3.85
200	288000									86.25	37.50	28.68	12.47	11.54	5.02
250	360000											45.21	19.66	17.84	7.76
300	432000											64.58	28.06	25.76	11.20
350	504000													34.96	15.20
400	576000													44.85	19.50
450	648000													57.50	25.00
500	720000													70.84	30.80

Frictional heads at given rates of discharge in clean cast iron pipes for each 1000 feet of length.

U. S. Gal. per Minute	U. S. Gal. per 24 Hours	4 In. Pipe Friction hd Feet	4 In. Pipe Friction hd Lbs.	5 In. Pipe Friction hd Feet	5 In. Pipe Friction hd Lbs.	6 In. Pipe Friction hd Feet	6 In. Pipe Friction hd Lbs.	8 In. Pipe Friction hd Feet	8 In. Pipe Friction hd Lbs.	10 In. Pipe Friction hd Feet	10 In. Pipe Friction hd Lbs.	12 In. Pipe Friction hd Feet	12 In. Pipe Friction hd Lbs	14 In. Pipe Friction hd Feet	14 In. Pipe Friction hd Lbs.
50	72000	2.01	.87	.67	.29	.32	.14								
100	144000	7.36	3.19	2.61	1.14	1.08	.47								
125	180000	12.19	5.29	4.07	1.77	1.68	.73								
150	216000	16.05	6.95	5.86	2.54	2.28	.99								
200	288000	28.09	12.17	10.32	4.48	3.92	1.70	1.01	.44						
250	360000	43.47	18.83	16.24	7.08	6.00	2.60	1.52	.66						
300	432000	62.20	26.94	23.40	10.20	8.52	3.69	2.13	.92	.75	.32				
400	576000	109.68	47.50	42.52	18.52	14.89	6.45	3.68	1.59	1.27	.55				
500	720000	170.53	73.87	64.90	28.20	23.01	9.97	5.64	2.44	1.93	.84	.81	.35	.40	.17
600	864000			90.20	39.30	32.89	14.25	8.03	3.48	2.72	1.18	1.14	.49	.55	.24
700	1008000			126.90	55.10	44.54	19.08	10.83	4.69	3.66	1.58	1.52	.66	.73	.32
800	1152000					57.95	25.10	14.05	6.08	4.73	2.05	1.96	.85	.94	.41
900	1290000					73.12	31.67	17.68	7.69	5.93	2.57	2.45	1.06	1.17	.51
1000	1440000					90.05	38.99	21.74	9.41	7.28	3.15	3.00	1.30	1.43	.62
1200	1728000							31.10	13.47	10.38	4.50	4.26	1.85	2.02	.88
1400	2016000							42.13	18.25	14.02	6.07	5.74	2.49	2.72	1.18
1600	2304000							54.84	23.75	18.22	7.89	7.44	3.22	3.51	1.52
1800	2592000							69.22	29.98	22.96	9.95	9.36	4.06	4.41	1.91
2000	2880000							85.27	36.93	28.25	12.24	11.50	5.00	5.41	2.34
2500	3600000									43.87	19.00	17.82	7.72	8.35	3.62
3000	4320000									62.92	27.25	25.51	11.05	11.93	5.17
3500	5040000											34.58	14.98	16.14	6.99
4000	5760000													21.00	9.10
4500	6480000													26.49	11.47

Friction of Water in Cast Iron Pipes—(Continued)

Frictional heads at given rates of discharge in clean cast iron pipes for each 1000 feet of length.

U. S. Gal. per Minute	U. S. Gal. per 24 Hours	16 In. Pipe Friction hd Feet	16 In. Pipe Friction hd Lbs.	18 In. Pipe Friction hd Feet	18 In. Pipe Friction hd Lbs.	20 In. Pipe Friction hd Feet	20 In. Pipe Friction hd Lbs.	24 In. Pipe Friction hd Feet	24 In. Pipe Friction hd Lbs.	30 In, pipe Friction hd Feet	30 In, pipe Friction hd Lbs.	36 In, Pipe Friction hd Feet	36 In, Pipe Friction hd Lbs.	42 In. Pipe Friction hd Feet	42 In. Pipe Friction hd Lbs.
500	720000	.22	.09												
1000	1440000	.76	.34	.44	.19										
1500	2160000	1.63	.71	.93	.40	.56	.24								
2000	2880000	2.28	1.22	1.60	.69	.96	.42	.41	.18						
2500	3600000	4.34	1.88	2.45	1.06	1.47	.64	.62	.27						
3000	4320000	6.19	2.68	3.48	1.51	2.09	.90	.87	.38	.30	.13				
3500	5040000	8.37	3.63	4.70	2.03	2.81	1.22	1.16	.50	.40	.17				
4000	5760000	10.87	4.71	6.09	2.64	3.64	1.58	1.50	.65	.52	.22				
4500	6480000	13.70	5.93	7.67	3.32	4.58	1.98	1.88	.82	.64	.28				
5000	7200000	16.85	7.30	9.43	4.08	5.62	2.43	2.31	1.00	.78	.34	.33	.14		
6000	8640000			13.49	5.84	8.03	3.48	3.28	1.42	1.11	.48	.46	.20		
7000	10080000					10.86	4.71	4.43	1.92	1.49	.65	.62	.27		
8000	11520000							5.75	2.49	1.93	.84	.80	.35		
9000	12960000							7.25	3.14	2.43	1.05	1.00	.43		
10000	14400000									2.98	1.29	1.23	.53	.63	.27
11000	15840000									3.59	1.55	1.47	.64	.76	.33
12000	17280000									4.25	1.84	1.74	.75	.91	.40
13000	18720000									4.97	2.15	2.03	.88	1.09	.47
14000	20160000									5.75	2.49	2.35	1.02	1.25	.54
15000	21600000									6.58	2.85	2.69	1.17	1.43	.62
16000	23040000											3.04	1.32	1.62	.71
17000	24480000											3.43	1.49	1.84	.80
18000	25920000											3.83	1.66	2.07	.90
20000	28800000											4.71	2.04	2.55	1.11

Friction of Water in Elbows

PRESSURE IN POUNDS PER SQUARE INCH TO BE ADDED FOR EACH ELBOW

Gallons per Min. Delivered	PIPE SIZES ¾	1	1¼	1½	2	2½	3	3½	4	5	6	7	8	9	10	12
5	.07	.027	.008	.005	.002											
10	.28	.094	.031	.018	.006	.003										
15	.63	.212	.069	.04	.014	.005										
20	1.12	.376	.123	.069	.025	.012	.005									
25	1.74	.585	.194	.108	.038	.02	.008									
30		.845	.278	.157	.055	.028	.011									
35		1.15	.380	.215	.076	.037	.015	009								
40		1.50	.495	.278	.098	.049	.02	.011	.007							
45		1.90	.626	.352	.125	.062	.026	015	.009							
50			.77	.43	.153	.08	.032	017	.01							
60		3.38	1.11	.62	.22	.112	.044	.026	.015	.006	.003					
70		4.60	1.52	.86	.304	.148	.06	.035	.021	.009	.004	.002				
75		5.30	1.74	.98	.35	.172	.072	.04	.024	.01	.005	.003				
80		6.00	1.98	1.11	.392	.196	.08	.044	.027	.012	.005	.003				
90		7.60	2.50	1.41	.50	.248	.104	.06	.035	014	.007	.004				
100			3.08	1.72	.612	.32	.128	.068	.043	.017	.008	.005	.003	.002		
125				2.72	.97	.48	20	.112	.067	.027	.013	.007	.004	.003	.002	
150				3.92	1.39	.685	.286	.16	.096	.039	.019	.01	.006	.004	.003	.001
175				5.32	1.90	.935	.390	.218	.132	.053	.026	.014	.009	.005	.004	.002
200				6.88	2.44	1.28	.512	.272	.172	.068	.032	.02	.011	.007	.005	.002
250					3.86	1.91	.80	.446	.268	.109	.025	.029	.017	.011	.007	.004
300					5.56	2.74	1.14	.64	3.84	.156	.076	.042	.025	.016	.01	.005
350						3.77	1.58	.88	.530	.215	.103	.057	.034	.022	.014	.007
400						5.12	2.05	1.09	.688	.272	.128	.08	.044	.028	.018	.009
450						6.20	2.58	1.45	.870	.352	.170	.094	.057	.036	.023	.011
500						7.64	3.20	1.78	1.07	.436	.208	.116	.068	.044	.028	.016
750									2.42	.970	.470	.260	.156	.10	.063	.031
1000									4.28	1.74	.832	.464	.272	.176	.112	.064
1250									6.70	2.71	1.31	.728	.435	.276	.175	.086
1500									9.68	3.88	1.88	.84	.624	.40	.252	.124

Wrought Pipe.
FULL STANDARD WEIGHT-BLACK AND GALVANIZED

ALL WEIGHTS AND DIMENSIONS ARE NOMINAL

Size	List Price per Foot	Diameters		Thickness	Weight per Foot		Threads per Inch
		External	Internal		Plain Ends	Threads and Couplings	
⅛	$ .05½	.405	.269	.068	.244	.245	27
¼	.06	.540	.364	.088	.424	.425	18
⅜	.06	.675	.493	.091	.567	.568	18
½	.08½	.840	.622	.109	.850	.852	14
¾	.11½	1.050	.824	.113	1.130	1.134	14
1	.17	1.315	1.049	.133	1.678	1.684	11½
1¼	.23	1.660	1.380	.140	2.272	2.281	11½
1½	.27½	1.900	1.610	.145	2.717	2.731	11½
2	.37	2.375	2.067	.154	3.652	3.678	11½
2½	.58½	2.875	2.469	.203	5.793	5.819	8
3	.76½	3.500	3.068	.216	7.575	7.616	8
3½	.92	4.000	3.548	.226	9.109	9.202	8
4	1.09	4.500	4.026	.237	10.790	10.889	8
4½	1.27	5.000	4.506	.247	12.538	12.642	8
5	1.48	5.563	5.047	.258	14.617	14.810	8
6	1.92	6.625	6.065	.280	18.974	19.185	8
7	2.38	7.625	7.023	.301	23.544	23.769	8
8	2.50	8.625	8.071	.277	24.696	25.000	8
8	2.88	8.625	7.981	.322	28.554	28.809	8
9	3.45	9.625	8.941	.342	33.907	34.188	8
10	3.20	10.750	10.192	.279	31.201	32.000	8
10	3.50	10.750	10.136	.307	34.240	35.000	8
10	4.12	10.750	10.020	.365	40.483	41.132	8
11	4.63	11.750	11.000	.375	45.557	46.247	8
12	4.50	12.750	12.090	.330	43.773	45.000	8
12	5.07	12.750	12.000	.375	49.562	50.706	8
13	5.60	14.000	13.250	.375	54.568	55.824	8
14	6.10	15.000	14.250	.375	58.573	60.375	8
15	6.50	16.000	15.250	.375	62.579	64.500	8

The permissible variation in weight is 5 per cent above and 5 per cent below.

Courtesy of National Tube Co.

Wrought Pipe.
EXTRA STRONG PIPE—DOUBLE EXTRA STRONG PIPE
FULL STANDARD WEIGHT
EXTRA STRONG PIPE—BLACK AND GALVANIZED
ALL WEIGHTS AND DIMENSIONS ARE NOMINAL

Size	List Price per Foot	Diamrters		Thickness	Weight per Foot Plain Ends
		External	Internal		
⅛	$ .12	.405	.215	.095	.314
¼	.07½	.540	.302	.119	.535
⅜	.07½	.675	.423	.126	.738
½	.11	.840	.546	.147	1.087
¾	.15	1.050	.742	.154	1.473
1	.22	1.315	.957	.179	2.171
1¼	.30	1.660	1.278	.191	2.996
1½	.36½	1.900	1.500	.200	3.631
2	.50½	2.375	1.939	.218	5.022
2½	.77	2.875	2.323	.276	7.661
3	1.03	3.500	2.900	.300	10.252
3½	1.25	4.000	3.364	.318	12.505
4	1.50	4.500	3.826	.337	14.983
4½	1.80	5.000	4.290	.355	17.611
5	2.08	5.563	4.813	.375	20.778
6	2.86	6.625	5.761	.432	28.573
7	3.81	7.625	6.625	.500	38.048
8	4.34	8.625	7.625	.500	43.388
9	4.90	9.625	8.625	.500	48.728
10	5.48	10.750	9.750	.500	54.735
11	6.10	11.750	10.750	.500	60.075
12	6.55	12.750	11.750	.500	65.415

The permissible variation in weight is 5 per cent above and 5 per cent below.

DOUBLE EXTRA STRONG PIPE—BLACK AND GALVANIZED
ALL WEIGHTS AND DIMENSIONS ARE NOMINAL

Size	List price per foot	Diameters		Thickness	Weight per Foot Plain Ends
		External	Internal		
½	$ .32	.840	.252	.294	1.714
¾	.35	1.050	.434	.308	2.440
1	.37	1.315	.599	.358	3.659
1¼	.52½	1.660	.896	.382	5.214
1½	.65	1.900	1.100	.400	6.408
2	.91	2.375	1.503	.436	9.029
2½	1.37	2.875	1.771	.552	13.695
3	1.86	3.500	2.300	.600	18.583
3½	2.30	4.000	2.728	.636	22.850
4	2.76	4.500	3.152	.674	27.541
4½	3.26	5.000	3.580	.710	32.530
5	3.86	5.563	4,063	.750	38.552
6	5.32	6.625	4.897	.864	53.160
7	6.35	7.625	5.875	.875	63.079
8	7.25	8.625	6.875	.875	72.424

The permissible variation in weight is 10 per cent above and 10 per cent below.

COMPARATIVE TABLE OF PIPE CAPACITIES
Number of Smaller Pipes Equivalent to One Larger

With the same velocity of flow, the volume delivered by two pipes of different sizes is proportional to the squares of their diameters. With the same head or pressure, however, the velocity is less in the smaller pipe and the volume delivered varies about as the square root of the 5th power. The table is calculated on this basis, the figures in each column showing the number of pipes of the size at the head of that column, equivalent in capacity to one pipe of the corresponding sizes given in side columns.

Large Pipe, Diam., Ins.	Smaller Pipes, Diameters, Inches															Large Pipe, Diam. Ins.
	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	
	Number to Give Same Capacity as One Large Pipe															
2	5.7	......	......	......	......	......	......	......	......	......	......	......	......	......	......	2
3	15.6	2.8	......	......	......	......	......	......	......	......	......	......	......	......	......	3
4	32.0	5.7	2.1	......	......	......	......	......	......	......	......	......	......	......	......	4
5	55.9	9.9	3.6	1.7	......	......	......	......	......	......	......	......	......	......	......	5
6	88.2	15.6	5.7	2.8	1.6	......	......	......	......	......	......	......	......	......	......	6
7	130	22.9	8.3	4.1	2.3	1.5	......	......	......	......	......	......	......	......	......	7
8	181	32.0	11.7	5.7	3.2	2.1	1.4	......	......	......	......	......	......	......	......	8
9	243	43.0	15.6	7.6	4.3	2.8	1.9	1.3	......	......	......	......	......	......	......	9
10	316	55.9	20.3	9.9	5.7	3.6	2.4	1.7	1.3	......	......	......	......	......	......	10
11	401	70.9	25.7	12.5	7.2	4.6	3.1	2.2	1.7	1.3	......	......	......	......	......	11
12	499	88.2	32.0	15.6	8.9	5.7	3.8	2.8	2.1	1.6	......	......	......	......	......	12
13	609	108	39.1	19.0	10.9	7.1	4.7	3.4	2.5	1.9	1.2	......	......	......	......	13
14	733	130	47.0	22.9	13.1	8.3	5.7	4.1	3.0	2.3	1.5	......	......	......	......	14
15	871	154	55.9	27.2	15.6	9.9	6.7	4.8	3.6	2.8	1.7	1.2	......	......	......	15
16	......	181	65.7	32.0	18.3	11.7	7.9	5.7	4.2	3.2	2.1	1.4	......	......	......	16
17	......	211	76.4	37.2	21.3	13.5	9.2	6.6	4.9	3.8	2.4	1.6	1.2	......	......	17
18	......	243	82.2	43.0	24.6	15.6	10.6	7.6	5.7	4.3	2.8	1.9	1.3	......	......	18
20	......	316	115	55.9	32.0	20.3	13.8	9.9	7.4	5.7	3.6	2.4	1.7	1.3	......	20
22	......	401	146	70.9	40.6	25.7	17.5	12.5	9.3	7.2	4.6	3.1	2.2	1.7	1.3	22
24	......	499	181	88.2	50.5	32.0	21.8	15.6	11.6	8.9	5.7	3.8	2.8	2.1	1.6	24

FLOW OF WATER IN PIPES

From "Book of Standards," (National Tube Company) 1913 Edition, Pages 277, 278, and 279.

The quantity of water discharged through a pipe depends on the head. If the discharge occurs freely into the air, this head is the difference in level between the surface of the water in the reservoir and the center of the discharge end of the pipe; if the lower end of the pipe is submerged, the head is the difference in elevation between the two water levels. The discharge for a given diameter depends also upon the length of the pipe, upon the character of its interior surface as to smoothness and upon the number and sharpness of its bends.

The head, instead of being an actual distance between levels, may be caused by pressure, as by pumping, in which case the head is calculated as a vertical distance corresponding to the pressure, 1 pound per square inch being equal to 2.309 feet head, or 1 foot head being equal to a pressure of 0.433 pound per square inch.

The total head operating to cause flow is divided into three parts: (1) the velocity head, which is the height through which a body must fall in a vacuum to acquire the velocity with which the water flows in the pipe. This is equal to $v^2 \div 2g$, in which v is the velocity in feet per second, and $2g = 64.32$. (2) The entry head, which is required to overcome the resistance to entrance to the pipe. With sharp-edged entrance the entry head equals about one-half of the velocity head; with smooth, rounded entrance the entry head is inappreciable; (3) the friction head, due to the frictional resistance to flow in the pipe.

In ordinary cases of pipes of considerable length the sum of the entry and velocity heads scarcely exceeds one foot; in the case of long pipes with low heads it is so small that it may be neglected.

When the flow becomes steady, the pipe is entirely filled throughout its length, and hence the mean velocity at any section is the same as that at the end, when the size is uniform. This velocity is found to decrease as the length of the pipe increases, other things being equal, and becomes very small for great lengths, which shows that nearly all the head has been lost in overcoming the resistances. The length of the pipe is measured along its axis, following all the curves, if there be any. The velocity considered is the mean velocity, which is equal to the discharge divided by the area of the cross section of the pipe. The actual velocities in the cross section are greater than this mean velocity near the center and less than it near the interior surface of the pipe.

The object of the discussion of flow in pipes is to enable the discharge which will occur under given conditions to be determined, or to ascertain the proper size which a pipe should have in order to deliver a given discharge. The subject cannot, however, be developed with the definiteness which characterizes the flow from orifices and weirs, partly because the condition of the interior surface of the pipe greatly modifies the discharge, partly because of the lack of experimental data, and partly on account of defective theoretical knowledge regarding the laws of flow. In orifices and weirs errors of two or three per cent may be regarded as large with careful work; in pipes such errors are common and are generally exceeded in most practical investigations.

It fortunately happens, however, that in most cases of the design of systems of pipes errors of five and ten per cent are not important, although they are of course to be avoided if possible, or, if not avoided, they should occur on the side of safety.

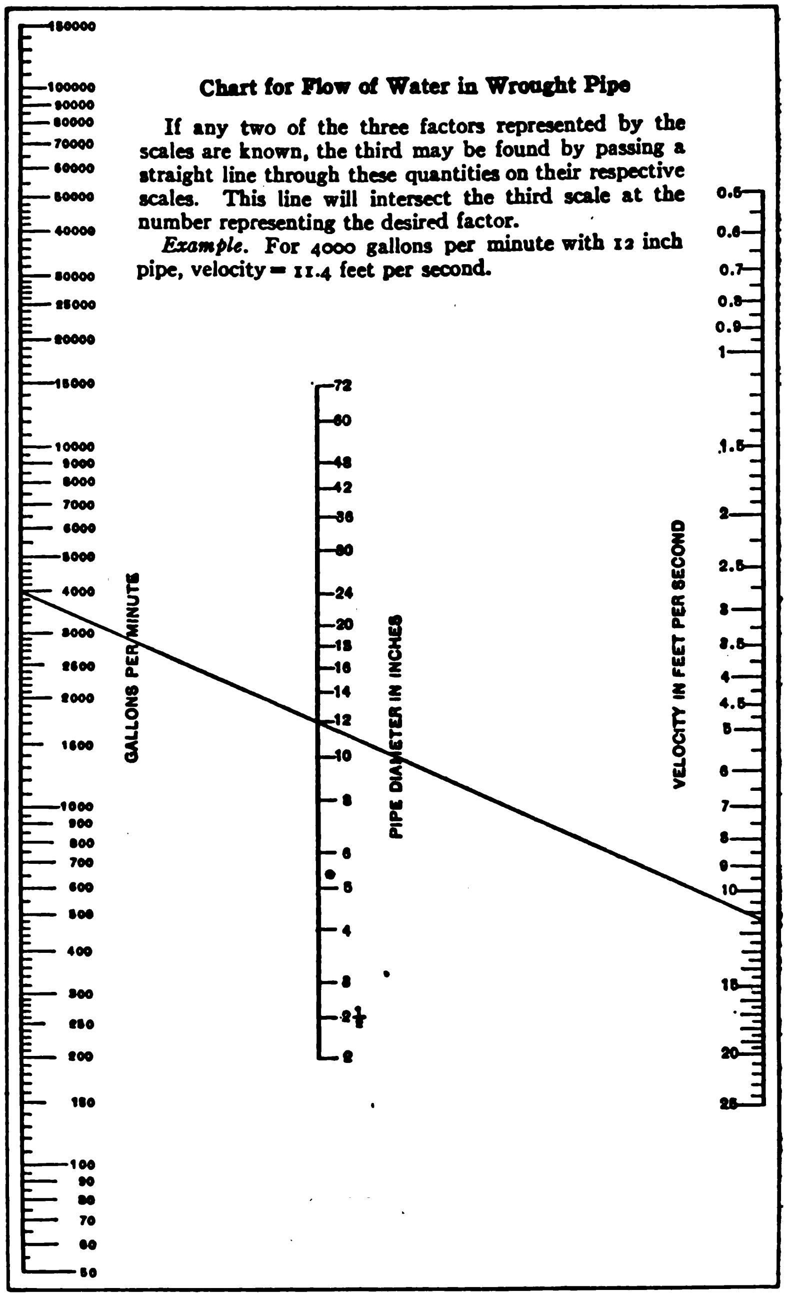


Chart for Flow of Water in Wrought Pipe

If any two of the three factors represented by the scales are known, the third may be found by passing a straight line through these quantities on their respective scales. This line will intersect the third scale at the number representing the desired factor.

Example. For 4000 gallons per minute with 12 inch pipe, velocity = 11.4 feet per second.

Quantity of Water Discharged

The quantity of water which flows through a pipe is the product of the area of its cross section and the mean velocity of flow. That is,

$$Q = av,$$

in which Q is the quantity discharged in cubic feet per second, a is the area in square feet and v is the velocity in feet per second.

For U. S. gallons per second multiply by	7.4805
For U. S. gallons per minute multiply by	448.83
For U. S. gallons per hour multiply by	26929.9
For U. S. gallons per 24 hours multiply by	646317.

The diagram above gives the discharge in gallons per minute when the velocity in the pipe line is known.

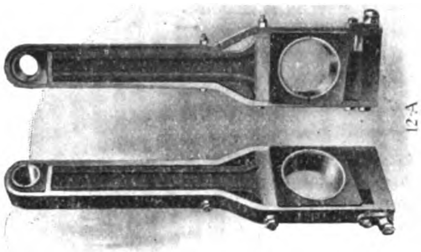
THE ALDRICH PUMP COMPANY

ALLENTOWN PENNA. U. S. A.

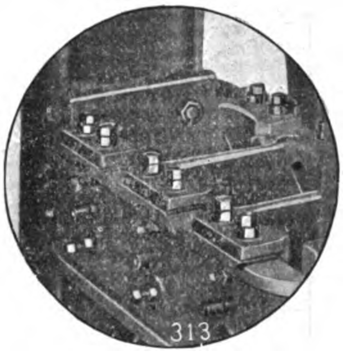
Electric and Power Mine Pumps

General Specifications

The connecting rods (Cut 12-A) are of the adjustable type with bronze boxes. A forged steel strap encircles the stub and bearing allowing adjustment of the boxes from one end by means of a wedge and screw, while the pump is running. The bearings are grooved and ample provision is made for proper lubrication.

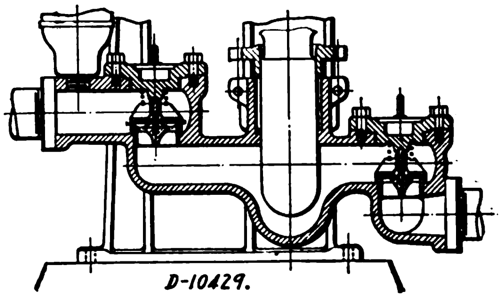


The cradle of cast iron is bolted between the main frames and carries the bored out adjustable ways for the crosshead (Cut 313).

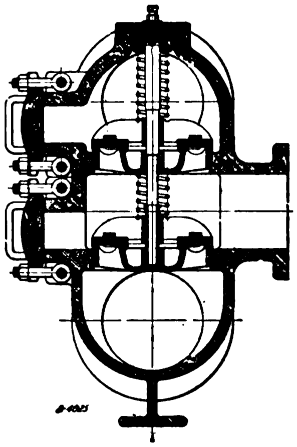


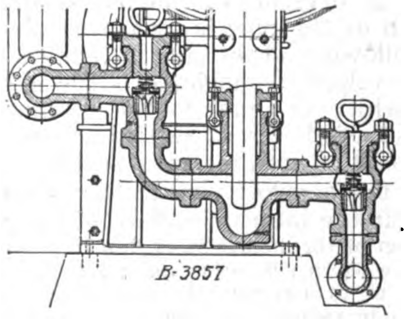
In the smaller sizes of horizontal pumps the main journals are cast in the main frames, but in the larger sizes of horizontal and all the vertical pumps, the main journals are separate from the main frames and are secured to them by heavy bearing caps accurately fitted to both. They are provided with babbitted bearings and can be adjusted by a wedge while the pump is running (Cut 46-A).

The Working Barrels and Valve Chambers are made of hard close grained cast iron of spherical and cylindrical construction, which gives them the maximum strength for the thickness of metal. The working barrels are bolted between the main frames with turned bolts.



The valve chambers contain the suction and discharge valves. Each valve has an independent cover held in position by heavy bolts. In the solid water end type (D-10429) the working barrel and valve chambers are in one casting, and in the divided water end type the valves are all in one chamber (B-4825) which is bolted to the working barrel, while in the pot chamber type (B-3857) there is a separate chamber for each valve. These chambers are bolted to the working barrel and are connected by the suction and discharge pipes.





General Types

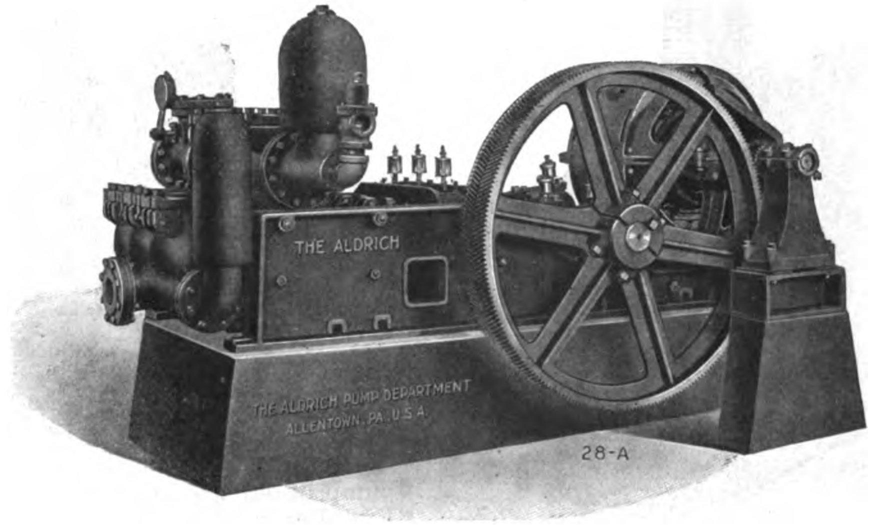


Figure 137.
Horizontal Triplex, Solid Water End Type.

Figs. 137, 119, 127 and 155

The illustrations on this page show our small station and portable Mine Pumps. Figures 137 and 119 operate at a moderate speed, about seventy revolutions, and are geared through a single reduction for moderately high speed motors. Figures 127 and 155 are the highest speed type operating at about one hundred revolutions and geared for operation by high speed motors. Where the water is acidulous, we recommend fitting pump with our special process cement lined water end, to gether with Bronze Lined Throats, Bronze Lined Glands, Lead Covered or Brass Cased Plungers, or if the water contains considerable grit, Chilled Iron Plungers.

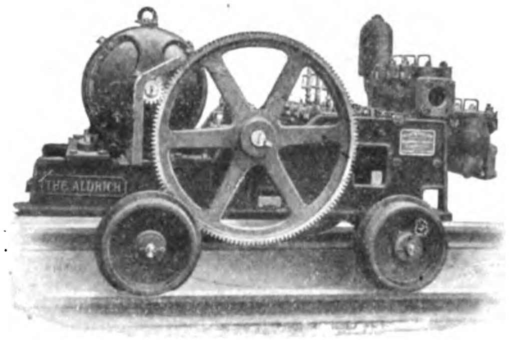


Figure 119.
Horizontal Triplex, Solid Water End Type.
Mounted on Trucks.

This Cement Lined, Bronze Fitted Water End will often equal the service of an all bronze water end, at a very small comparative cost. We have hundreds of these small pumps in very successful operation throughout the anthracite and bituminous coal fields of Pennsylvania; also in many other large coal fields.

Figures 119 and 155 illustrate Figures 137 and 127 respectively, mounted on trucks which make them particularly adapted for working on slopes, in incline shafts or pumping dips.

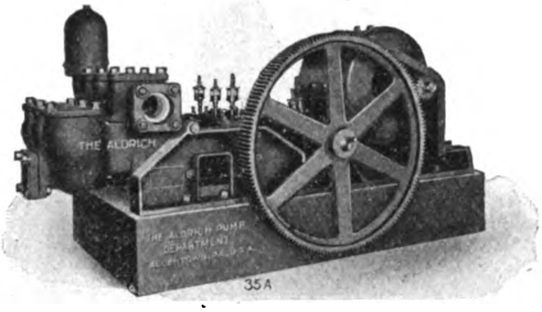


Figure 127.
Horizontal Triplex, Solid Water End Type.
High Speed.

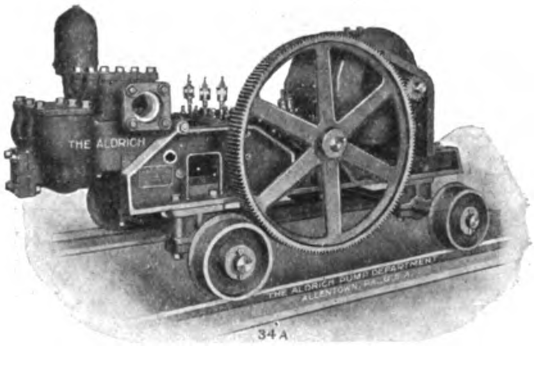


Figure 155.
Horizontal Triplex, Solid Water End Type.
High Speed—Mounted on Trucks.

Figures 137 and 119 are built in capacities of 25 to 350 G. P. M. against 100 feet to 18 and 100 G. P. M. against 1,000 feet. Figures 127 and 155 in four sizes, 50, 100, 140 and 240 G. P. M. against 100 and 175 feet.

Send for Pump Datas 34 and 51 respectively.

General Types

Figs. 110, 170 and 211

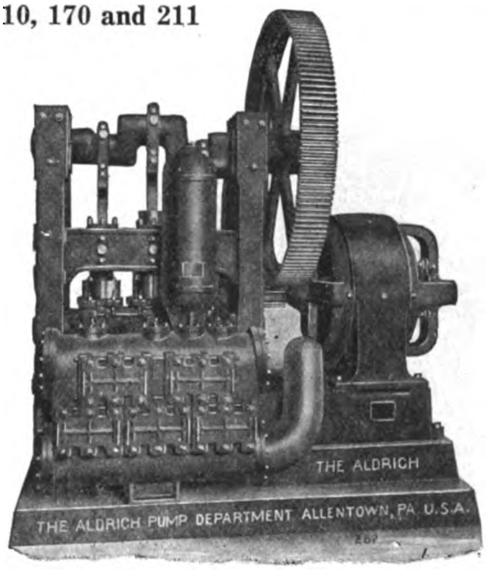


Figure 110.
Vertical Triplex Divided Water End Type.

Where large quantities of water are to be pumped against low lifts the Divided Water End Type is recommended. The single reduction geared pump is illustrated by Figure 110, but any type of drive is permissible. Built in capacities of 350 to 1,800 G. P. M. against 100 feet, up to 350 to 1,200 G. P. M. against 350 feet. Pump Data 32 covers fully.

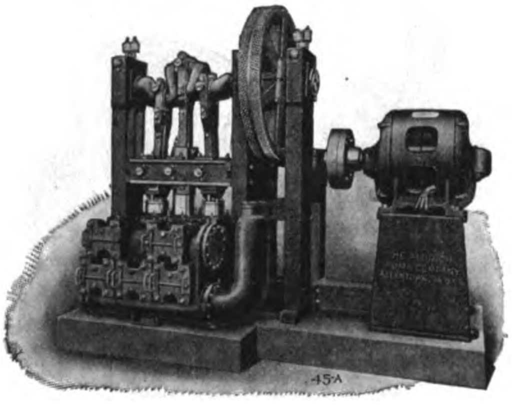


Figure 170.
Vertical Triplex Divided Water End Type, with Herringbone Gear Drive.

Figure 170 with its Herringbone gearing, outboard standard and flexible coupling makes a very smooth operating and efficient drive, at the same time permitting of large speed reduction. Pump Data 41 is the one to send for.

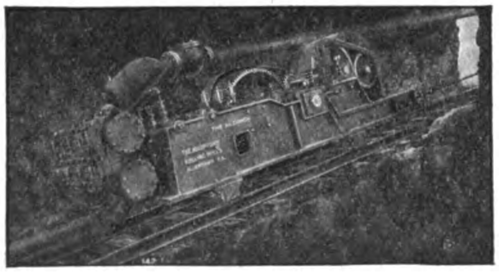


Figure 211.
Horizontal Triplex Divided Water End Type.

Where the headroom is restricted the pump can be built in a horizontal plane as illustrated in Figure 211, and when mounted on trucks as shown, it makes a large capacity portable pump. Send for Data 38.

Figs. 125 and 112.

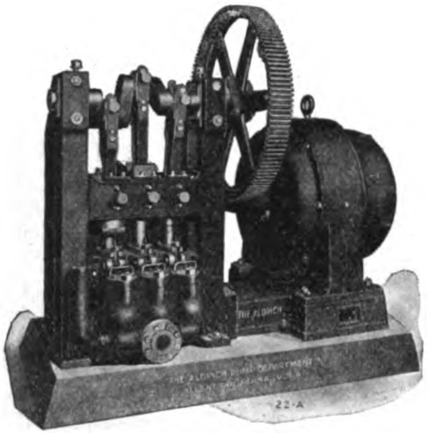


Figure 125.
Vertical Triplex, Solid Water End Type.

Figure 125 is the single reduction, direct geared pump in our group of Vertical Triplex Solid Water End Pumps. This group is adapted for all purposes and can be arranged for many different types of drive; belt, chain, double reduction geared, motor on top, etc. Built in capacities of 18 to 350 gallons per minute against 100 feet, up to 13 and 175 G. P. M. against 1,000 feet. For mine service they should be cement lined and bronze fitted. Our Pump Data 31 gives complete specifications and range of operation.

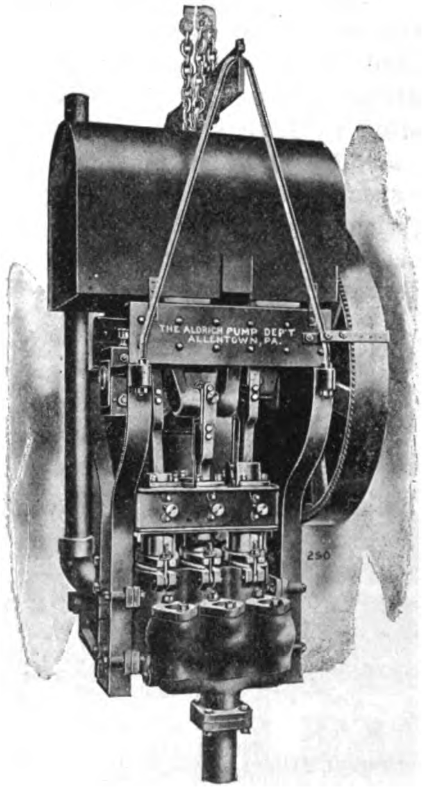


Figure 112.
Triplex Sinking Pump—Solid Water End Type.

Figure 112 is our Sinking Pump, designed for operating in a vertical shaft. It is fitted with sling, which permits raising and lowering as may be desired. Gearing and motors are steel encased for protection against water drip and falling rock. Built in capacities of 50 to 300 G. P. M. against 350 feet head. Send for Pump Data 44, giving complete details.

General Types

Figs. 164 and 146

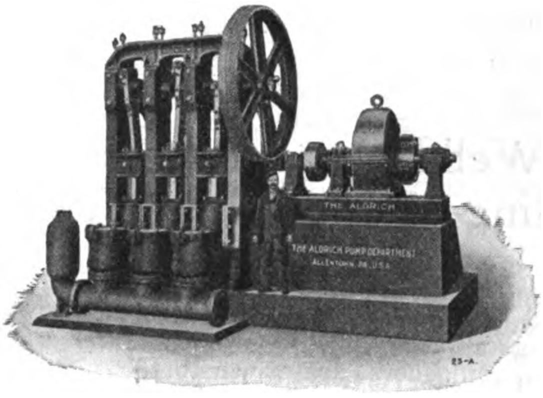


Figure 164.
Vertical Triplex, Four Standard, Cement Lined, Pot Chamber Water End Type.

The Pot Chamber Pump allows the use of a sectionalized water end, an arrangement which is considered one of the most essential in pump construction.

While this type is adapted for general pumping requirements, such as water works, paper mills, steel plants, etc., it is especially suited for mine service.

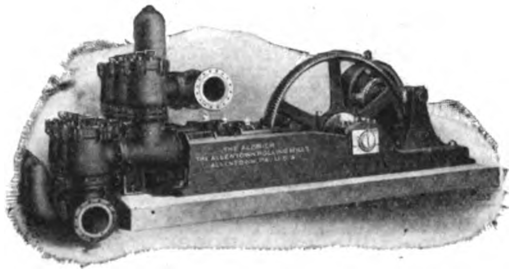


Figure 146.
Horizontal Triplex, Four Standard, Wood Lined, Pot Chamber Water End Type.

For a permanent mine station where the water to be pumped is acidulous, the wood or cement lined pump is recommended. The entire water end is wood or cement lined, increasing the life of the parts against the action of the acid water.

Pump Data 49 will give complete range of operation and types of drive for Figures 164 and 146. For capacities of 500 to 1,800 G. P. M. against 500 feet, up to 1,200 G. P. M. against 1,000 feet, while Pump Data 33 covers Figures 139 and 239, and Pump Data 39 describes Figure 136. Built in capacities of 100 to 1,200 G. P. M. against 350 feet up to 35 to 400 G. P. M. against 1,000 feet.

Figs. 139, 239 and 136

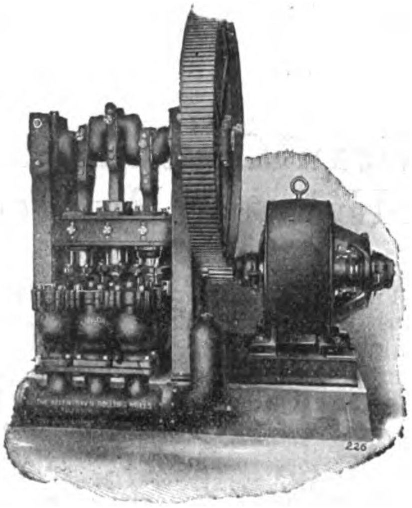


Figure 139.
Vertical Triplex, Pot Chamber Water End Type.

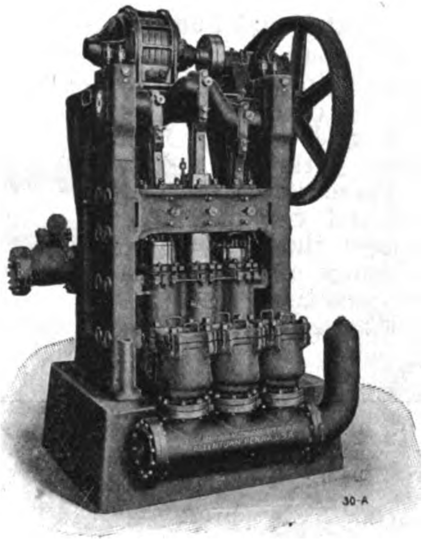


Figure 239.
Vertical Triplex, Pot Chamber Water End Type. Motor Mounted on Top.

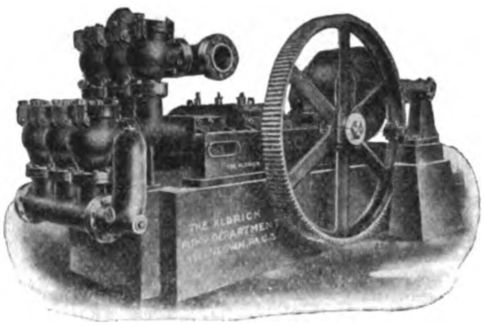


Figure 136.
Horizontal Triplex, Pot Chamber Water End Type.

THE AMERICAN WELL WORKS

General Office and Works: Aurora, Ill.
Chicago Office: First National Bank Bldg.

DISTRICT SALES AGENCIES:

NEW YORK CITY (Domestic and Export)
PHILADELPHIA, PA.
PITTSBURGH, PA.
ST. PAUL, MINN.
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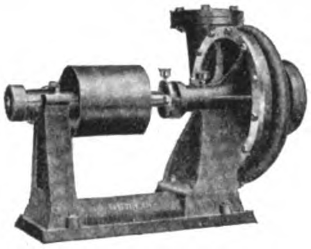
SALT LAKE CITY, UTAH
DENVER, COLO.
KANSAS CITY, MO.
JOPLIN, MO.
ST. LOUIS, MO.
CALGARY, ALTA.
BIRMINGHAM, ALA.

Manufacturers of

"American" Centrifugal and Deep Well Plunger Pumps; Well, Blast Hole and Prospecting Drilling Machines and Tools.

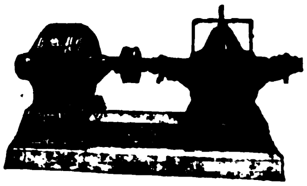
Products

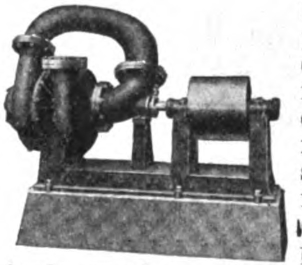
High and low head volute and turbine centrifugal pumps for every purpose, including mine sinkers, sump pumps, mine station pumps, acid pumps, drainage pumps, water works pumps, power plant pumps, feed water pumps; Deep Well Plunger pumps, single acting, double acting and two stroke; Deep Well Earth and Rock Drilling Machines; Deep Blast Hole Drilling Machines; Rotary Drilling and Coring Machines; complete line of Earth and Rock Tools.

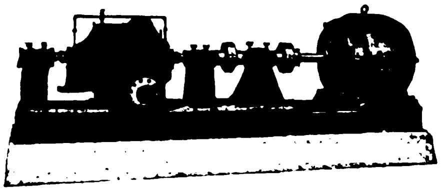


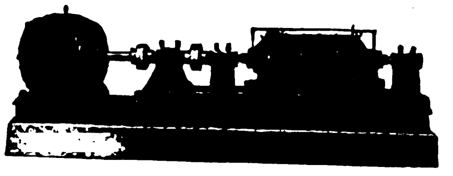
"American" Centrifugal Pumps

These pumps are made in about twenty standard types, including both horizontal and vertical styles, each in a complete line of sizes, and pumps are equipped with any power. These include both volute and turbine designs to meet the widest possible range of conditions. In addition to regular styles we are constantly designing and building special types of pumps to meet unusual conditions, including those for handling gritty water or a large quantity of solid matter and special composition and lead lined pumps for handling acids and chemicals. Centrifugal pumps are made with both single suction and double suction in the single stage pumps, and multiple stage pumps are made in any number of stages required to handle water under any practical pumping lift.





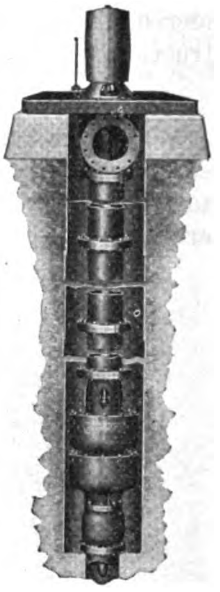




The important features of "AMERICAN" centrifugal pumps are skillful designing, so that high efficiencies are obtained with flat efficiency curves, making them economical through a wide range of delivery, the use of good material in their construction and careful machining and adjusting. Bearings are ring oiled from oil reservoirs. Impellers are given both rotative and end thrust balance. Single suction, open impeller types have the sides and edges of impellers and interior of casing carefully machined and closely adjusted to prevent leakage. Double suction types are fitted with labyrinth rings around suction openings to reduce leakage to the minimum. Multiple stage, enclosed impeller types, are designed to have fewest points of leakage back to the suction opening and to require packing on discharge side only against the pressure of the first stage, thus reducing friction on the shaft. Multiple stage opposed impeller types have long radius bends connecting the stages in pairs, equalizing the end thrust of one impeller by the end thrust of another in the opposite direction.

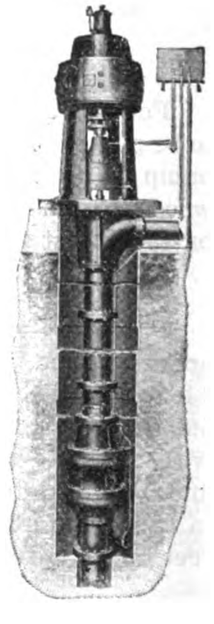
Testing

Pumps made from each set of patterns in all sizes of stock pumps and all special designed pumps are carefully tested under working conditions and their characteristics plotted. No pump is permitted to leave our works that does not equal or excel our guaranteed efficiency.



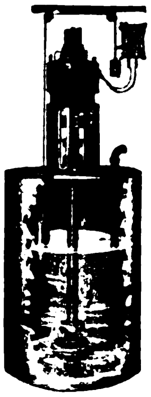
Efficiency

By skillful designing and careful workmanship "American" centrifugal pumps are able to compete in efficiency with any others of their type made by other manufacturers. The larger the pump and higher the head within certain limitations the higher the efficiency. Several standard types of these pumps are designed in larger sizes to maintain highest efficiencies on heads to 200 feet. Special designed pumps have been built by us to maintain highest efficiency on over 400 feet in the single stage types. These pumps obtain efficiencies up to 85 per cent.



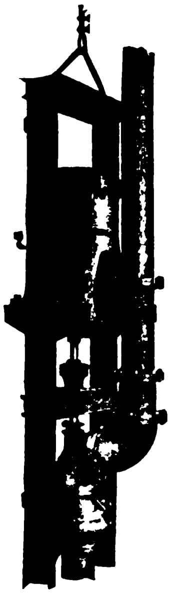
Equipment

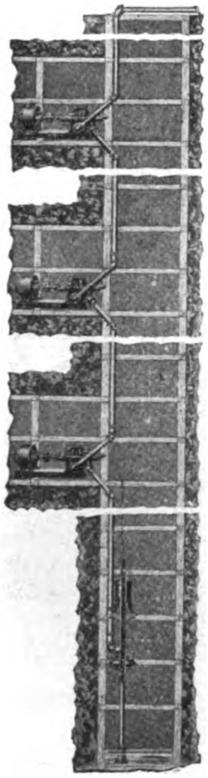
"American" centrifugal pumps are equipped with plain pulley for belt drive, with grooved pulley for rope drive, steam engine, internal combustion engine, electric motor, steam turbine or hydraulic turbine. Pumps are also supplied unmounted, with flexible shaft coupling for any power or mounted on base but without attached power.



Mine Sinker Pumps

American mine shaft sinking centrifugal pumps are made in both single and multiple stage balanced units mounted in steel frames with electric motors and are designed to be supported either to the shaft frame or suspended by cable from the surface, permitting them to be readily raised out of the way when blasting and to be lowered as required. These pumps may be mounted in special frames with combination horizontal and vertical motors for operating in inclined shafts. American mine sinkers are characterized by the small space occupied in the shaft, the small amount of piping required to connect them to surface, great reliability, high efficiency and large capacity.



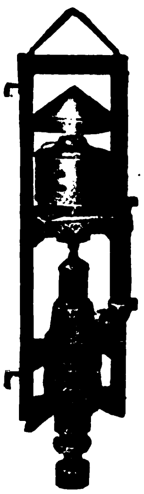


Mine Station Pumps

The great simplicity and compact design of American centrifugal pumps combined with their high efficiency and great reliability make them particularly suited to every requirement of a mine station pump. They are made in any size and for any head the conditions require. They may be made, on special order, with special bearings for operating in an inclined position. Special types of these pumps are made with steel shells for pumping against the highest practical heads. Pumps are also made of special composition metals for handling any mine or acid solutions.

Gritty Water Pumps

"American" type P centrifugal pumps are especially designed for handling water containing a large amount of grit such as is frequently encountered in mine development work. These pumps have the bearings wholly removed from the volute chamber so that it is impossible for grit to interfere with the lubrication of the pump.



Power Plant Pumps

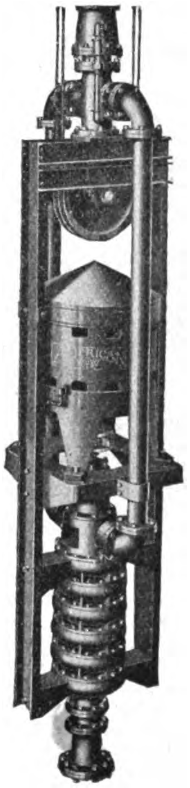
"American" power plant pumps are made in any style or capacity, and for any head the conditions require. Many of these pumps are supplied completely bronze fitted for the highest duty under the most exacting requirements.

"American" Drilling Machines

"American" deep well, blast hole, and rotary drilling machines are built in over fifty styles and sizes to meet every requirement of machines for these purposes. "American" rotary coring machines are unexcelled for prospecting work where a reliable core is desired.

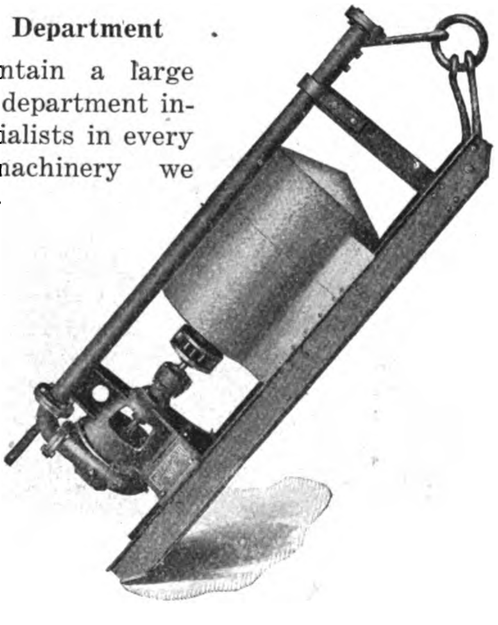
Catalogs

American Centrifugal Pumps are described in Catalog 149, and American drilling machines and tools in Catalog 145. These catalogs will be mailed to you on request.



Engineering Department

We maintain a large engineering department including specialists in every line of machinery we manufacture. The services of our engineers are always at the disposal of those contemplating the purchase of any of our machinery.



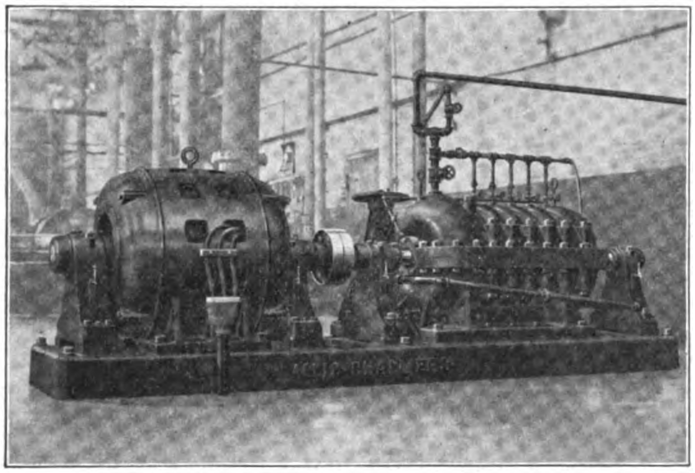
Allis-Chalmers Manufacturing Company

MILWAUKEE, WISCONSIN
Branch Offices in All Principal Cities

Centrifugal Pumps and Combined Responsibility Driving Motors or Turbines

Products

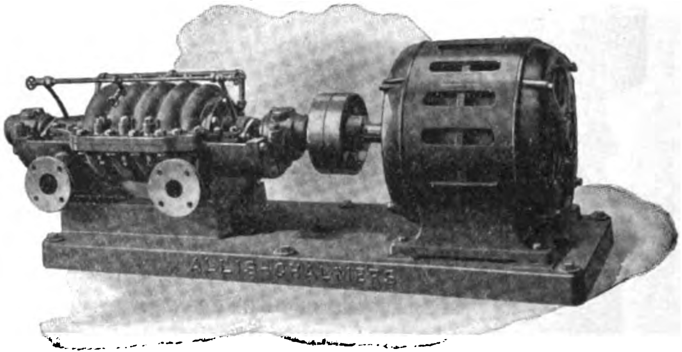
Horizontal bronze fitted split casing single and multistage pumps for mine drainage, unwatering mines, pumping out dips, etc., complete with driving motor of the Company's manufacture tested before shipment.



1,000 G. P. M., 815 Foot Head Pump Installed by the Ohio Salt Company, 1914.

Nearly ten years experience in building pumps for service in mines during which time many useful improvements have been embodied in the design of our pumps prove that properly selected COMPLETE CENTRIFUGAL PUMP UNITS are well adapted to this serivce. Nearly one hundred large pumps furnished, over a quarter of these being made of acid resisting bronze, indicate the utility of our standard designs and the repeat orders from customers using our pumps show that the economy and durability are all that can be desired.

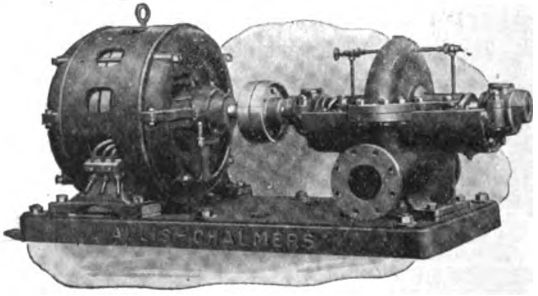
In selecting the pump best suited to special requirements the Company's engineers will apply their experience to your needs, which will be insurance that the combined unit recommended will meet all requirements PROVIDED WE GET YOUR INQUIRY.



Type "S" Motor Driven Single Stage Pump.

Type "S" Pumps

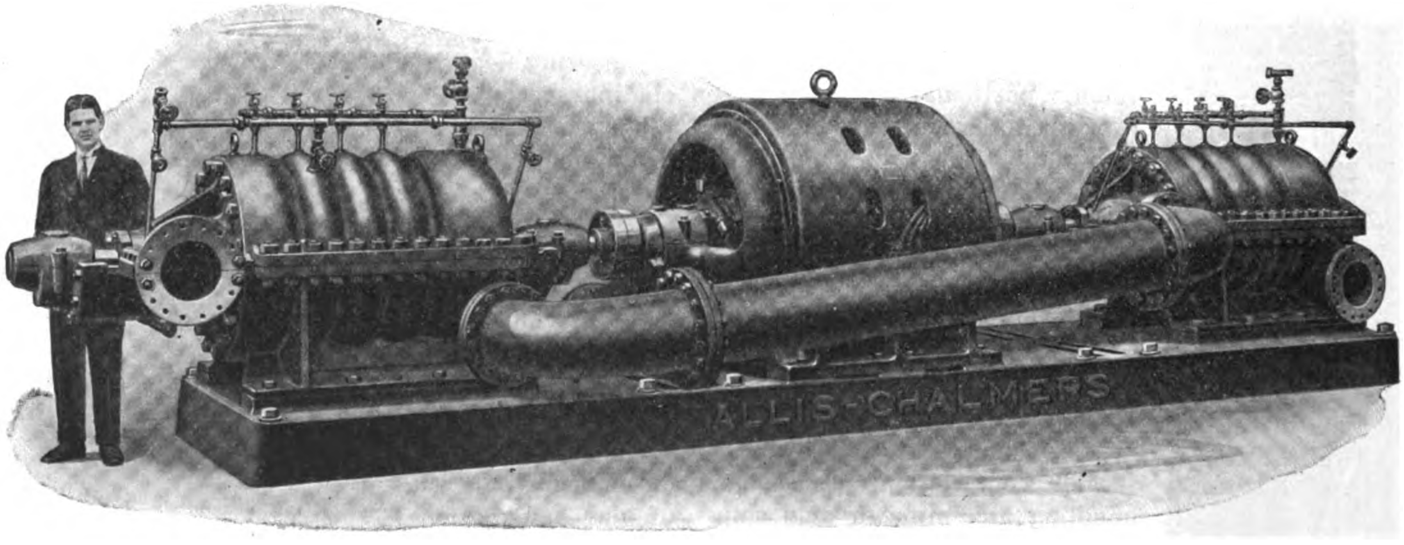
Are the Company's recently developed high efficiency single stage pumps suitable for general service of all kinds requiring capacities from 75 G. P. M. to 20,000 G. P. M. against heads up to 200 feet.



Motor Driven Multistage Pump.

Multistage Pumps

Are used for the higher lifts not only in mines but also for boiler feeding, fire pumps, hydraulic mining, slucing, etc. Our standard sizes are built for heads up to 1,000 feet in any reasonable capacity.



10 in. 10-Stage Solid Bronze Mine Drainage Pump.

Bulletin No. 1632-A Will Be Forwarded Upon Request

AMERICAN STEAM PUMP CO.

BATTLE CREEK, MICHIGAN

New York Office: 17 Battery Place. MANUFACTURERS OF Chicago Office: 1220 Monadnock Block.

Marsh and American Steam and Power Driven Pumps and Air Compressors

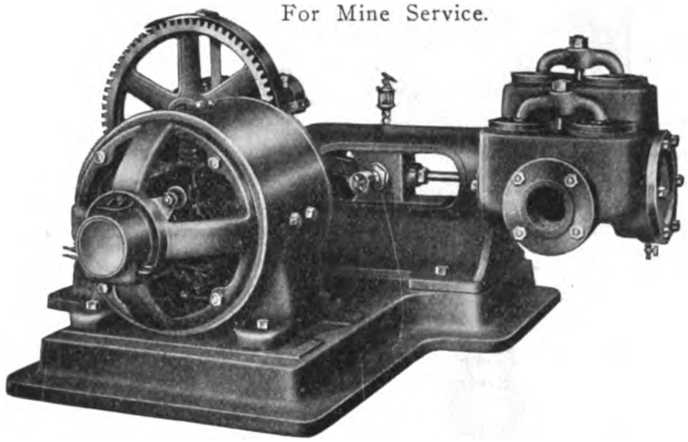
Represented by

DRAVO-DOYLE CO.

Pittsburg, Cleveland Indianapolis, Philadelphia

American Gathering or Dip Pump

For Mine Service.



A portable outfit especially designed for taking care of surplus water accumulating in the side sumps or pockets of mines.

Water end constructed of acid-proof metal.

Instant access to all water valves by simply loosening two nuts. This is very desirable when handling mine water in which small pieces of coal or other foreign matter are likely to clog the valves.

Specifications: The frame is of the heavy box type with the metal carefully distributed to best withstand the severe strains to which it is subjected. The crosshead guides are cylindrical and bearings are lined with genuine babbit and scraped to a true bearing. Connecting rod is of cast steel, crosshead end of solid type with brass boxes. Crank end of marine type with heavy studs and babbitt lined. Crosshead of box type with adjustable bronze shoes.

Pump end is equipped with removable acid-proof bushing. Valve areas are ample and water ways easy. Piston is connected to crosshead by solid acid proof rod.

A suitable sub-base is furnished, as shown in illustration, under both pump and motor.

Size, 5x6: Capacity, 60 gallons per minute; 3 inch suction, 2½ inch delivery. Code word, Dippy.

Size, 6x8: Capacity, 100 gallons per minute; 3½ inch suction, 3 inch delivery. Code word, Dipsop.

Note: When writing for prices on motor driven outfit, be sure to give the voltage and character of your current, i. e., whether direct or alternating, and if the latter, what cycle and phase.

Marsh and American Steam Pumps

Marsh and American Pumps are made both in the piston and outside center packed plunger patterns. They are fully bronze fitted at regular prices including solid bronze piston rods and cast bronze removable water cylinder bushings. They will not short-stroke, race or pound under the most severe conditions. The absence of outside valve motion on the Marsh Pump reduces the repair cost to a minimum and is especially recommended where it is necessary to employ cheap labor to care for the pump as the valve is set before leaving the factory and requires no adjustment. Marsh and American Pumps are guaranteed to operate on 25% less steam than any duplex pump on the market.

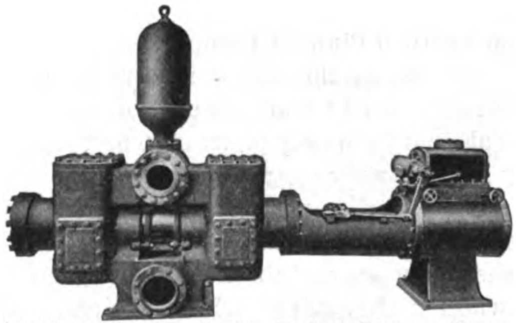
Power Pumps

American single and duplex horizontal power pumps vary in capacity from 6 to 1,000 gallons per minute. They are made with the same high grade of material and workmanship which characterize Marsh and American steam pumps. They are simple in design and very rugged in construction. They are furnished with or without motors as desired.

Marsh Piston Type Boiler Feed Pump

Air Compressors

American Improved steam and power driven air compressors have capacities ranging from 3 to 850 cubic feet of air per minute. They are of the most approved and up-to-date design and highest efficiency is guaranteed.



American Outside Center Packed Plunger Pump.

Bulletins

We issue a series of 23 bulletins each covering a different type of pump. Write us for bulletins covering the types in which you are interested or we will be glad to furnish the complete set neatly bound upon request.

A. S. CAMERON STEAM PUMP WORKS

Manufacturers of

Staem, Centrifugal and Triplex Pumps

Main Office, 11 Broadway, N. Y.

Branch Offices in All Large Cities

Cameron Steam Pumps
have been widely used in coal mines for over half a century, because they are unusually simple, compact, strong, durable and economical. Fewer working parts than any other steam pump.. Only four pieces in the steam mechanism. By simply removing the valve chest cover the whole interior of the water cylinder is in full view. The suction and discharge valves are held in place by one stem, which can be removed by unscrewing one plug. Combined with these advantages is the Cameron high grade of material and workmanship.

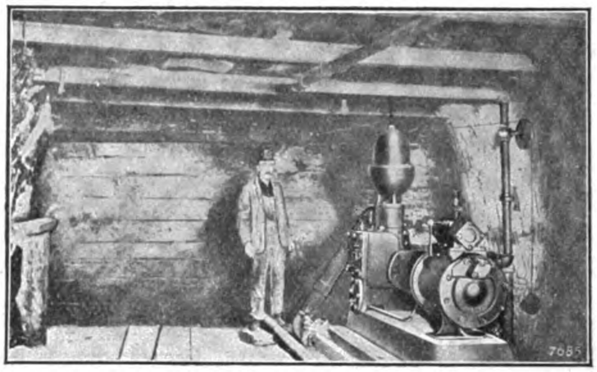
The Cameron Piston Pump
(Shown in the upper illustration)
is built for all classes of service, in capacities from 10 G. P. M. to 1000 G. P. M. against 400 feet head at ordinary speed. The water cylinders are made with or without fixed or loose linings, or entirely of our special acid resisting metal.

Cameron Horizontal Plunger Pumps
(Shown in the second illustration)
have all the economical operating features of the piston type described above. They are especially built to handle gritty water. In the water end there are no wearing parts, except the packing in the stuffing boxes, which can be instantly adjusted from the outside. The pump barrel cannot get worn by grit or sand, as the plunger works in loose sleeves. Built in capacities from 10 G. P. M. to 1200 G. P. M. to work against 400 feet head at ordinary speed.

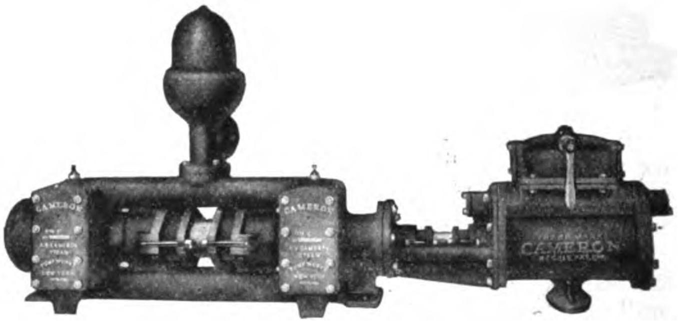
Cameron Vertical Plunger Pumps
(Shown in the lower illustration)
have gained a world wide reputation as the most successful shaft sinking pumps. They are exceptionally simple and strong. They take up less room in the shaft than any other pump, and have no outside parts to get damaged by collision with the side walls. They are certain in operation, can handle gritty water and require little attention. Built in capacities from 25 G. P. M. to 1600 G. P. M. to work against heads of 400 feet at ordinary speed.

The reliability and efficiency of CAMERON PUMPS has been tested in thousands of coal mine installations.

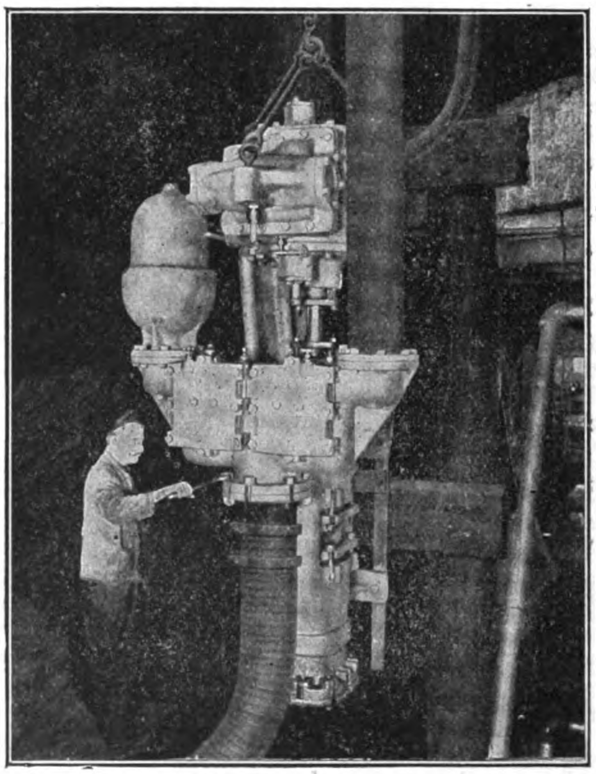
Full information in Bulletin No. 104—It's free.



Cameron 14 x 9 x 18 Steam Piston Pump, 350 G. P. M. Working Against 300 ft. Head, in Ill. Coal Mine.



Cameron Horizontal Plunger Pump for Coal Mine Service.



Cameron 20 x 12 x 16 Vertical Plunger Pump, 600 G. P. M., Working Against 300 Feet Head, in a Penn'a. Coal Mine.

Cameron Centrifugals are most modern in design and built with the special aim to produce a combination of high working value and low operating cost. Actual tests have proved that they are highly efficient and economical.

The superintendent of a Pennsylvania Coal Mine writes: "The Cameron Centrifugal, which took the place of another make, delivers 20% more water than the other pump did when new."

The Cameron Double Suction Volute Pump

(Shown in the upper illustration)

is built for moderate heads. It has an enclosed impeller and the casing is horizontally split. By removing the upper casing the working parts are easily reached without disturbing pipe connections or pump alignment.

Built in capacities from 50 G. P. M. to 15000 G. P. M., in a variety of speeds, and for heads from 10 to 200 feet. Described in Bulletin No. 150.

The Cameron Multi-Stage Pump

(Shown in the second illustration)

is built for high heads. It is very simple, strong and dependable. Its efficiencies are high and continue over a long period of service. The impellers are enclosed, and the horizontally split casing gives quick access to the working parts.

Built in two, three and four stages, for capacities from 75 G. P. M. to 2,500 G. P. M. and heads from 120 to 800 feet. Described in Bulletin No. 151.

The Cameron Single Suction Pump

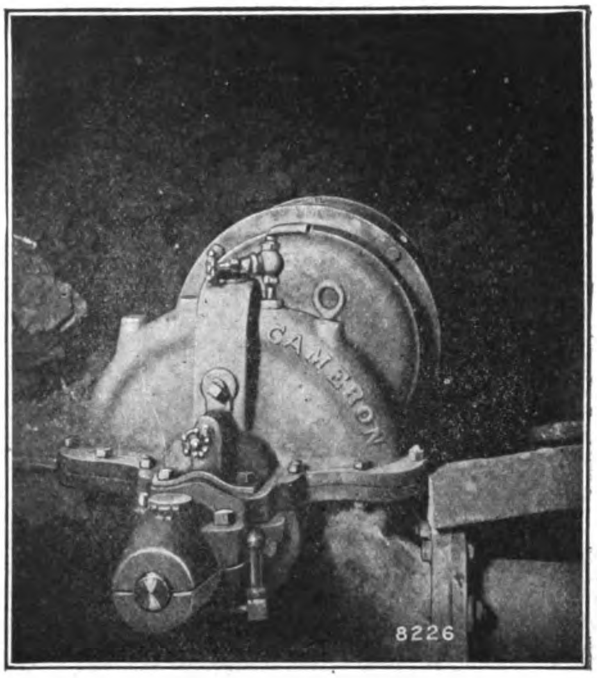
(Shown in the lower illustration)

is strong and rugged all through. The impeller is of the open type. This pump is very efficient in handling mine water, which contains grit and small solids.

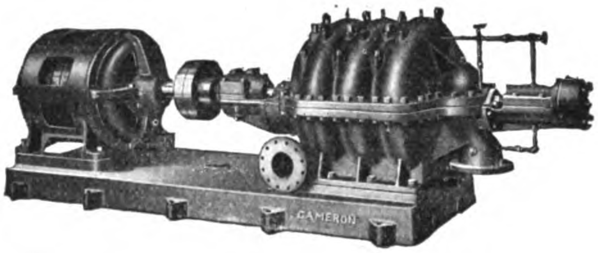
Built in capacities from 200 G. P. M. to 8,000 G. P. M. for heads up to 70 feet. Described in Bulletin No. 152.

All these CAMERON CENTRIFUGALS can be direct connected to electric motor or steam turbine, or can be arranged to suit any motive power.

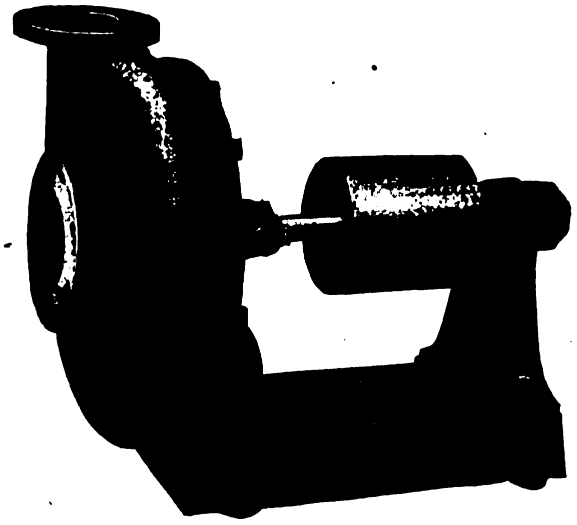
Write for Bulletins.



Cameron 4" Double Suction Volute Centrifugal Pump, Installed in a Penn'a. Coal Mine.



Cameron 6" Four-Stage Centrifugal, Delivering 1000 G. P. M., Against 500 Feet Head, in a Tenn. Mine.



Cameron Open Impeller Belt Driven Pump for Heads Up to 70 Feet.

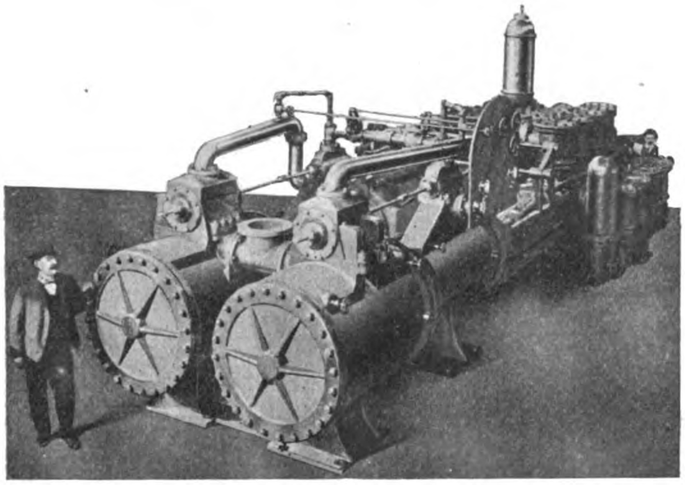
Connellsville Mfg. & Mine Supply Co.

Main Office and Works
CONNELLSVILLE, PA
Brown-Marx Building, Birmingham, Ala.
Manufacturers of

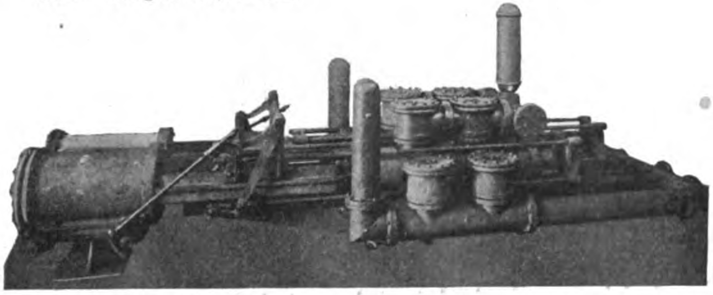
Steam, Electric and Compressed Air Pumps

We design and build practically every variety of Steam, Electric and Compressed Air Pumps, covered by the Lepley patents.

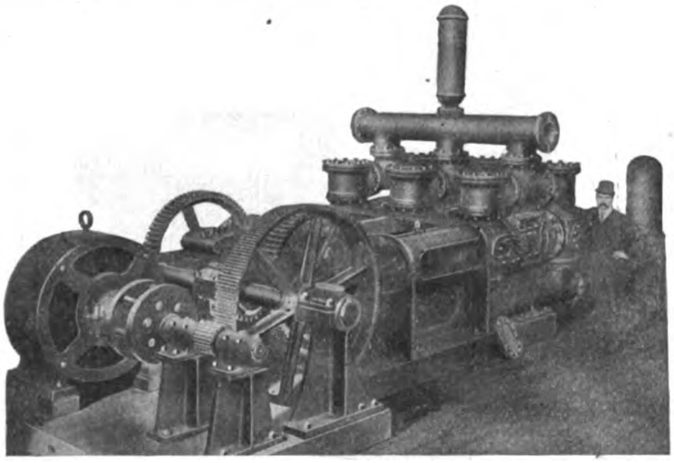
Our specialty is wood, lead and bronze protected Mine Pumping Units of large capacities.



20 x 40 x 16 x 48" Duplex, Tandem, Compound, wood lined Mine Pump. Maximum capacity 4000 gallons against 600 ft. head. Weight 150,000 lbs.



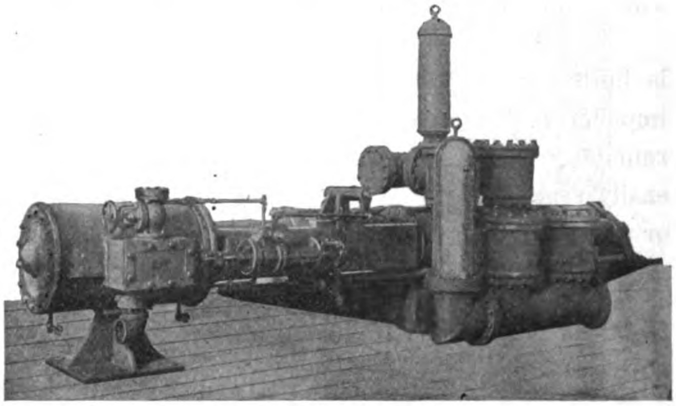
24 x 10 x 36" Duplex, Compressed Air Mine Pump, wood, lead and bronze fitted. Normal capacity 1000 gallons per minute. Weight 55,000 lbs. Guaranteed to run 100 ft. piston travel per minute without freezing.



10 x 18" Triplex, horizontal, double acting, electrically driven Mine Pump, wood, lead and bronze fitted. Normal capacity 1200 gallons per minute against 500 ft. head. Weight 85,000 lbs. Most accessible throughout and carries highest efficiency records.

We have had over thirty years of experience in designing and building Mine Pumping Units for the very worst conditions. Our experience and advice are yours for the asking.

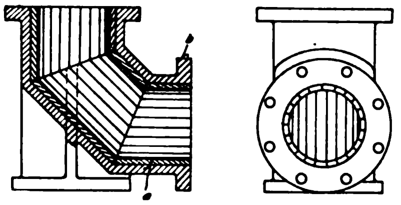
Our records: Efficiency—Satisfaction.

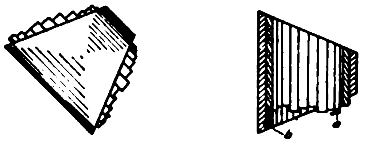


24 x 12 x 36" Single, wood lined Mine Pump. Normal capacity 550 gallons per minute.

Lepley and Baer Wood Lined Elbow

In most mining operations there is more or less water to pump, and it nearly always contains enough acid to soon eat out unprotected pipe lines and connections. This has led to the practice of wood lining all pumping lines and fittings that will permit of it.





On account of the extreme difficulty and cost of satisfactorily wood lining radial elbows and the fact that 90 degree or square turn elbows are not efficient, we have developed the design and method of wood lining shown in the cut. This we have termed our improved octagon elbow, and it possesses practically the same economical characteristics of the radial type. The wood lining in this type of elbow will give as good service as that in a straight pipe or a 90 degree elbow, and can be installed at very much less cost than that of the radial elbow.

Made in diameters from 6 to 16 inches, in varying lengths in plain flanged type, or with supporting base as shown in the cut.

De Laval Steam Turbine Company

TRENTON, N. J.

Dravo-Doyle Co., Merchant Engineers

Sole Representatives in Pittsburgh and Cleveland

Cost of Pumping

Is made up of the cost of power, the cost of labor and superintendence, and the cost of the pump itself. For pumps operated continuously, as in coal mines, the first two are by far the most important. A few per cent. difference in efficiency, calling for more current and more capacity in cables and central station equipment, will in a short time cover the difference in cost between a high efficiency pump like the De Laval and an ordinary low-efficiency pump.

As to cost of superintendence and labor, shut-downs and repairs take men's time and also lost for you the use and benefit of the pump while it is shut down, perhaps compelling you to provide spare pumping equipment.

De Laval pumps, however, are so constructed that repairs are rarely required, and when necessary, can be made in a very short time by relatively unskilled men. All internal and working parts are accessible upon lifting the casing cover and can then be removed after taking off the bearing caps. It is not necessary to break piping connections or to move the pump or the driving motor in order to do this. All parts subject to wear are made on a limit-gage, interchangeable basis, and spares ordered from the factory by the number which is stamped on each part, will fit accurately and can be put into place at once.

Leakage through the joints between the casing and impeller, the most frequent cause of loss of efficiency in ordinary pumps, is minimized by removable labyrinth wearing rings. Special acid-resisting metal is employed to prevent corrosion by mine water. Carefully selected and tested materials are used throughout.

De Laval Centrifugal Pumps are built in the single-stage and multi-stage types for all heads and capacities. Each unit is fully guaranteed as to capacity and efficiency and is fully tested in the shop before shipment.

De Laval Steam-Turbine-Driven Centrifugal Pumps

Hold the records as to low cost in handling water, due to their low first cast and high thermal efficiency. Because of their light weight and compactness, large sums are saved on the cost of foundations and buildings. They should be used wherever water is to be handled in large quantities against any head.

De Laval Steam Turbines

Are of the Impulse Type, having large clearances, and are carefully constructed of high grade materials. By the use of the De Laval Speed-Reducing Gear, the steam turbine is employed for driving all types of machinery, including large centrifugal pumps and blowers and direct current generators, and for rope and belt drives, the turbine and the driven machine running each at its respectively best speed.

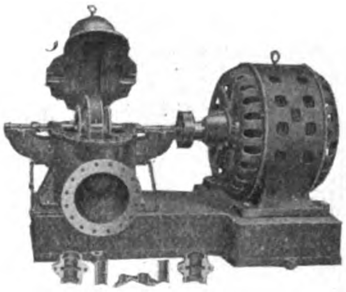
De Laval Turbine-Driven Direct-Current Generators

Are of the standard, slow-speed type, with which operating men are familiar, and are free from the many troubles inherent in high-speed generators.

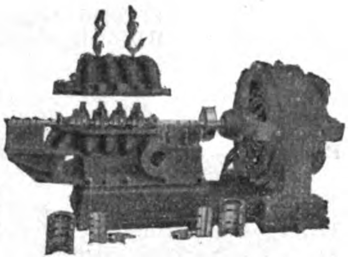
De Laval Steam-Turbine-Driven Steam Plant Auxiliaries

Including Ceitrifugal Circulating Pumps, Centrifugal Boiler Feed Pumps and Centrifugal Fans and Blowers, are simple and compact, requiring little attention.

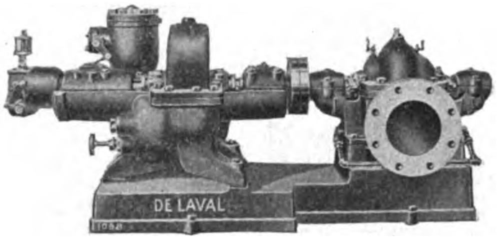
State requirements fully, so that special literature may be sent.



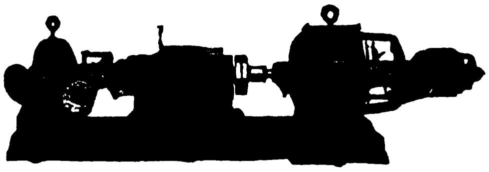
Typical De Laval Horizontal Single-Stage Pump with casing cover and bearing caps removed for inspection of internal parts.



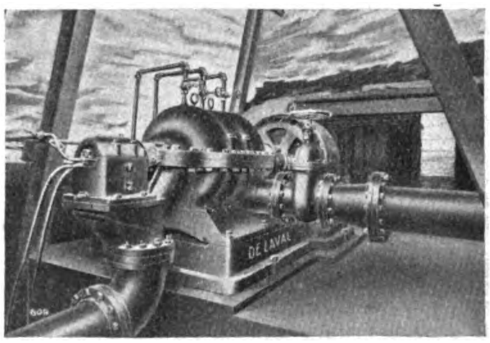
De Laval Multi-Stage Centrifugal Pump driven by electric motor; cover lifted and bearing caps removed, showing accessibility.



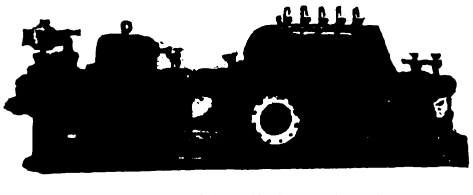
De Laval Turbine-Driven Single-Stage Pump.



De Laval Geared Turbine driving Standard-speed Alternator.



De Laval Three-Stage Station Pump in Coal Mine.



De Laval Steam Turbine Driven Air Compressor.

THE DEMING COMPANY

SALEM, OHIO

HAND AND POWER PUMPS FOR ALL REQUIREMENTS

GENERAL AGENCIES

PITTSBURGH, Harris Pump & Supply Co. NEW YORK, Ralph B. Carter Co.
CHICAGO, Henion & Hubbell DENVER, Hendrie & Bolthoff Mfg. & Supply Co.

Agencies in All Principal Cities.

Products

Hand and Power Pumps for mine service and for general water supply, including:

Triplex Power Pumps
which are made in vertical or horizontal types; portable or stationary; single or double acting; electric or belt driven; many different styles and sizes; standard or special construction as conditions may necessitate; capacities from 5 gallons per minute to 2,000 gallons per minute.

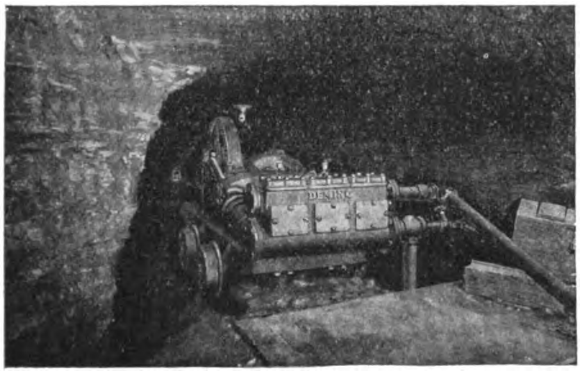


Fig 70 Deming Triplex Portable Mine Pump, installed in "Banning" Mine of the Pittsburgh Coal Co. For description of this pump, see page 562 of this catalogue.

Power Piston Pumps
Electric or belt drive; stationary or portable; standard or special construction, to suit conditions; capacities from 20 to 200 gallons per minute. Trade names, "Neptune," "Vulcan," and "Ajax."

Deep Well Working Heads and Cylinders
Electric or belt driven; standard or special construction to suit conditions; for pumping water from deep wells for general water supply.

Economy

Deming Mine Pumps are the result of more than twenty years' experience in the design and construction of pumping equipment for mine service.

They are compact; have plenty of valve area and easily accessible valves; are "built for long wear." The way in which Deming Mine Pumps stand up under the most exacting conditions is a source of wonder to experienced mine men.

When used as sump pumps, gathering pumps, station pumps, boiler feeders, etc., Deming Power Pumps give the greatest posible returns on the investment.

They require so little attention they are almost automatic. Many mines have been able to dispense entirely with the pump man, after changing over from steam pumps to electric driven Deming Pumps.

Service

Large stocks of standard mine pumps and motors are carried at Salem, Pittsburgh, Chicago, and Denver for prompt shipment. Wire orders are given especial attention.

Experienced engineers at the factory and branch agencies are prepared to furnish expert advice concerning outfits which will best suit existing conditions.

Information Required For Estimate

It is difficult to make any specific statements concerning the maximum distances which any mine pump will lift and force water either vertically or horizontally. This can be acurately determined only when the conditions under which the pump will operate are definitely known.

We, therefore, prefer to treat each installation as a separate case, and suggest that we be supplied with the information requested under the heading, "When Ordering Pumps," as given on page 540. Upon receipt of this data, our engineers will be enabled to quote on a pump which will suit the conditions in all respects.

Many Mines Standardize on Deming Power Pumps

In the extensive list of mines which are Deming equipped are several companies which have **installed over two hundred Deming Mine Pumps in their various workings.** There are also a number of mines using **over one hundred Deming Pumps.** These companies have standardized on Deming equipment and use Deming Pumps only, in all their mining properties.

The names of many of these large users of Deming Mine Pumps together with names of users in your immediate vicinity will be sent if desired.

The letter below is **typical of hundreds which we have on file from satisfied users.** Many of these are from customers with whom we have been doing business for nearly twenty years.

> "Our Deming Pumps have been running almost continuously since they were purchased and we have always felt that they were a most satisfactory and economical pump. The pump purchased in 1906, 7 x 8, Fig. 70, is pumping from 1200 to 1500 feet up a 5% grade and has never given us any trouble whatever, and we are glad to recommend your pumps to anyone who is in the market."
>
> Yours very truly,
>
> NORTON COAL COMPANY,
> Norton, Va.

Guarantee

Our pumps are fully guaranteed to perform the duty for which they are rated or recommended, and we shall hold ourselves under obligation to supply, without charge, any part breaking within one year of date of shipment, where such breakage bears unmistakable evidence of faulty material or workmanship.

Catalogues

In addition to our many different pumps for mine service, we also make hundreds of styles and sizes of hand, and power pumps for all uses, which are described in the following departmental catalogues:—

Power Pump Catalogue "J"—192 pages devoted to triplex and other power pumps; deep well working heads and cylinders, etc.

General Catalogue No. 25—360 pages; covering our pitcher spout pumps; well pump standards; set length lift and force pumps; complete hydro pneumatic water systems; pumps for miscellaneous uses; cylinders, well supplies, etc.

Spray Pump Catalogue—40 pages, describing our bucket, knapsack, cart, barrel, tank, field and power sprayers, also nozzles and accessories for all spraying conditions.

DEMING TRIPLEX MINE PUMPS

DEMING SINGLE-ACTING TRIPLEX PLUNGER PUMP, FIG. 50

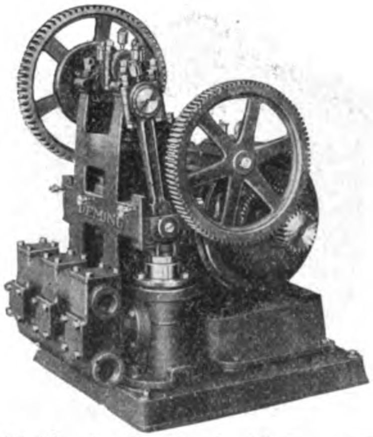


Fig. 50, Size 4 x 6 to 5 x 6 with Type "B" Drive.

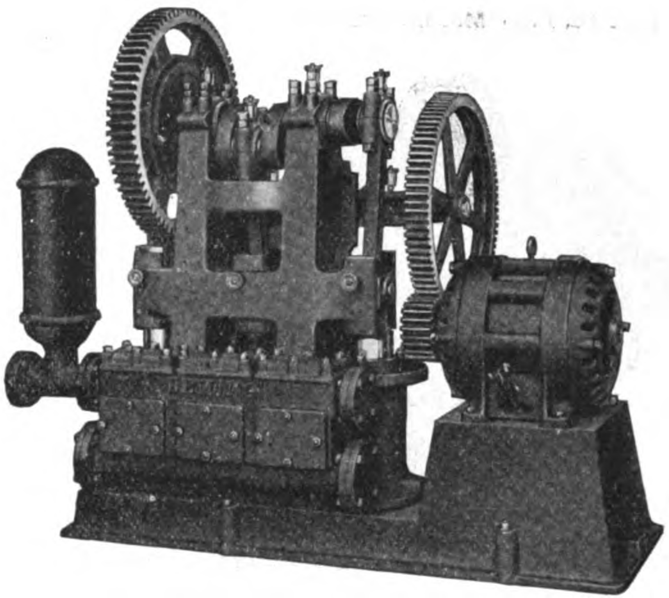


Fig. 50, Size 5½ x 8 with Type "B" Drive.

For General Service

This is one of our most popular vertical triplex power pumps for mine service and general water supply. It is well adapted for long distance pumping and is good for approximately 350 feet head. We have been manufacturing this particular type with a few modifications for more than twenty years and many of the first ones made are still in use and giving good service.

Specifications of Fig. 50

Frame consists of two standards, and includes crosshead guides and main crank shaft bearings, the latter being lined with best anti-friction metal. In sizes 4x4 and smaller the frame is cast in one piece with the cylinders.

Crank Shaft is of best open hearth steel casting in one piece.

Gearing is machine cut, and is double in 10-inch stroke sizes, and in sizes 11x12 and larger. Other sizes made with double gearing at extra price.

Pinion Shaft is of steel, running in boxes lined with best anti-friction metal, and bolted to the main housings.

Connecting Rods, in sizes 4x6 and larger, have bronze boxes with wedge and screw adjustment at crosshead end, and marine type babbitted boxes at crank end. Smaller sizes have bronze bushings at crosshead ends.

Crossheads run in bored guides, sizes 4x6 and larger having adjustable bronze shoes.

Plungers are of hard, close-grained cast iron, finished true and smooth, and reciprocate through packing of ample depth.

Cylinders and Base are in one casting in sizes 10x10 and smaller, and in larger sizes the cylinders are in three separate castings bolted to the base.

Valve Chambers, in sizes 3½x4 and larger, are separate castings bolted to the cylinders. They are of liberal proportions, affording large valve area, and all valves are readily accessible.

Valves for cold water are rubber discs, protected on top from cylindrically wound springs by brass plates. For hot water either special hard composition valves or bronze valves are furnished as ordered.

Valve Seats are of bronze, screwed into decks, and are of the grid type. Iron seats and valves furnished when conditions require.

Air Chamber furnished when specified. Vacuum Chamber to order.

Grease Cups, or Oil Cups if specified, and wrenches furnished with all pumps.

Type "B" Drive (Cipher, "TYPEB") includes sub-base on which both pump and motor are mounted, and with gearing connection between pump and motor.

Fig. 50, Standard Sizes, Capacities, Etc.

Plungers		Capacity		Max. Working Pressure, Lbs.	Diam. of Pipes		*Tight and Loose Pulleys	Cipher
Diam. Inches	Stroke Inches	Jsual Rev. per Min.	Gals. per Min.		Suction Inches	Dischg. Inches		
2	2	70	5.67	150	1½	1	8x 2	Obese
2½	2	70	8.89	150	1½	1	10x 2	Oberlize
2½	3	60	11.4	150	2	1½	12x 3	Oaken
3	3	60	16.2	150	2	1½	14x 3	Oath
3½	3	60	22.	150	2.	1½	16x 3	Oakling
3½	4	60	30.	150	2½	2	16x 4	Obelus
4	4	60	39.	150	2½	2	18x 4	Oakum
4	6	60	59.	160	2½	2	20x 5	Oarsman
4½	6	60	74.	150	3	2½	20x 5	Oaky
5	6	60	91.	150	3	2½	24x 5	Oasis
5½	8	60	147.	150	4	3	28x 6	Oatmeal
6	8	55	161.	140	4	3	30x 6	Obduration
7	8	55	220.	150	5	4	30x 8	Obdurate
8	8	55	287.	150	5	4	36x 8	Obiter
8½	8	55	324.	140	6	5	36x 8	Obdure
8	10	50	326.	140	6	5	36x 8	Overcoat
9	10	50	413.	160	8	6	42x10	Obloquy
10	10	45	459.	150	8	6	42x12	Obsignate
10	12	42	514.	140	8	8	42x14	Objuration
11	12	42	622.	160	10	8	48x14	Obduct
12	12	42	740.	150	10	8	48x16	Obduction
12	14	40	822.	150	12	10	48x18	Observance
13	14	40	965.	140	12	10	48x20	Observant

*Sizes 9x10 and larger regularly furnished with tight pulley only. Gear ratio is 5 to 1.

DEMING TRIPLEX MINE PUMPS

SPECIFICATIONS OF STANDARD VERTICAL AND HORIZONTAL TYPES

Fig. 40, For Medium Service

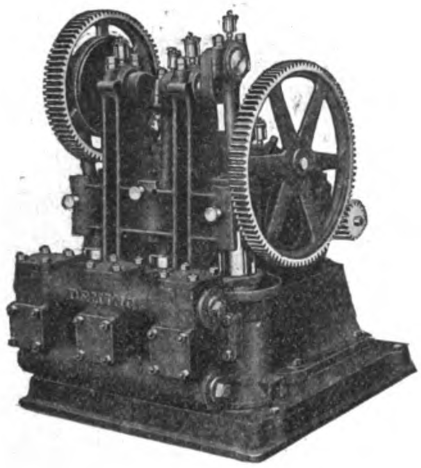


Fig. 40, Sizes 4 x 6 to 5½ x 6 with Type "B" Drive.

For Medium Service

Our Fig. 40 single-acting triplex power pump is quite similar in general construction to Fig. 50, described on preceding page. Fig. 40 however, is built for somewhat lighter duty. It is good for approximately 200 feet head.

We are unable to give complete specifications covering Fig. 40 because of limited space, but will be glad to forward specific data on request.

Type "B" Drive (Cipher "Typeb") includes sub-base on which both pump and motor are mounted, and with gearing connection between pump and motor.

Fig. 40, Standard Sizes, Capacities, Etc.

Plungers		Capacity		Max. Working Pressure, Lbs.	Diam. of Pipes		*Tight and Loose Pulleys.	Cipher
Diam. Inches	Stroke Inches	Usual Revs. per Min.	Gallons per Min.		Suction Inches	Dischg. Inches		
4	6	60	59	100	2½	2	16 x 4	Obcordate
4½	6	60	74	95	3	2½	18 x 4	Obtusion
5	6	60	91	90	3	2½	18 x 4	Objector
5½	6	60	111	75	3½	3	18 x 4	Obeying
5½	8	60	147	85	4	3	20 x 5	Obituary
6	8	55	161	70	4	3	20 x 5	Obfirm
7	8	55	220	100	5	4	28 x 6	Oblation
8	8	55	287	100	5	4	30 x 6	Obtund
8	10	50	326	90	6	5	30 x 6	Obsequent
9	10	50	413	85	6	5	30 x 8	Obtrusive
10	10	45	459	90	8	6	36 x 8	Obeah
11	12	42	622	90	10	8	36 x 10	Obi
12	12	42	740	75	10	8	36 x 10	Obitual
12	14	40	822	100	12	10	44 x 10	Object
13	14	40	965	85	12	10	44 x 10	Objecting
14	14	40	1119	75	12	10	46 x 10	Objective

*Note—Sizes 10 x 10 and larger furnished with tight pulley only.

Gear ratio 5 to 1.

Fig. 70, For General Service

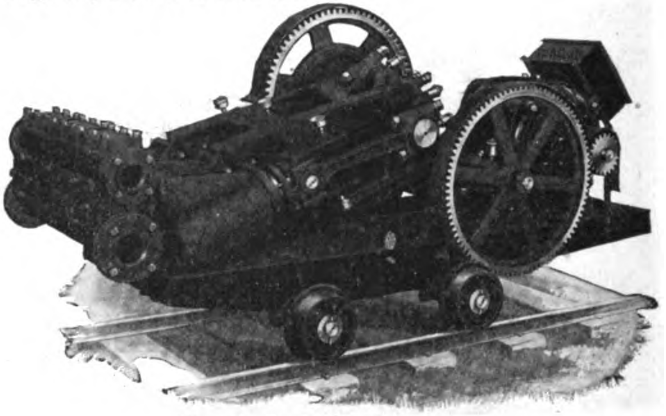


Fig. 70, Portable Mine Pump.

Fig. 70 Portable Electric Driven Triplex Mine Pump is of the horizontal, single-acting, outside packed and outside guided plunger type, and is especially designed for pumping out mine sumps. It is very compact, requiring a minimum amount of head room, and being mounted on a portable truck, is easily moved from place to place as required. The truck is wholly of iron, and not affected by moisture, thereby insuring permanency of alignment of pump and motor.

The standard construction of the working parts of the pump, including guide columns, crank shaft, gearing, connecting rods, plungers, valve chambers, etc., is the same as for corresponding sizes of our Fig. 50 vertical pump, shown on preceding page, and insures the promptness in furnishing repair parts, which is so essential in mining operations.

The cylinders are of special design to meet the conditions imposed by the horizontal type.

Standard construction includes iron plungers, glands, cylinders and valve chambers, and iron truck complete with wheels having a 9-inch diameter tread; intermediate gear and rawhide motor pinion for connecting motor, but motor is not included unless so specified.

All gearing is carefully protected by steel guards. Truck wheels of other diameter than 9-inch furnished, when specified. Grease cups, or oil cups if specified, and wrenches furnished with all pumps.

Special Construction: Brass cased plungers, or solid bronze plungers, and bronze lined stuffing boxes and glands, or entire water end made of bronze, at extra price.

Correspondents should state gauge of track, height of roof, suction lift, discharge elevation and approximate lengths and diameters of pipes, and should also furnish dimensions of motor, if ordering.

We can furnish Fig. 70 with a base for stationary service, if desired. Pump is then designated as Fig. 71.

Fig. 70, Standard Sizes, Capacities, Etc.

Plungers		Capacity			Max. Head Feet.	Diam. of Pipes		*Cipher
Diam. Inches	Stroke Inches	Gals. per Rev.	Usual Rev. per Min.	Gals. per Min.		Suction Inches	Dischg. Inches	Standard Fitted
3½	4	.50	60	30	300	2½	2	Organism
4	4	.65	60	39	300	2½	2	Organist
4	6	.98	60	59	320	2½	2	Ordinal
4½	6	1.24	60	74	300	3	2½	Orbate
5	6	1.53	60	91	300	3	2½	Ordinance
5½	8	2.46	60	147	300	4	3	Ordinate
6	8	2.94	55	161	280	4	3	Orgasm
7	8	4.00	55	220	300	5	4	Ordination
8	8	5.22	55	287	300	5	4	Orgy
8½	8	5.90	55	324	280	6	5	Ordinator

Gear Ratio 5 to 1. Intermediate Gears, Special.

DEMING HORIZONTAL TRIPLEX PLUNGER PUMPS FOR MINES

WITH GUARDED GEARS AND ACCESSIBLE VALVES

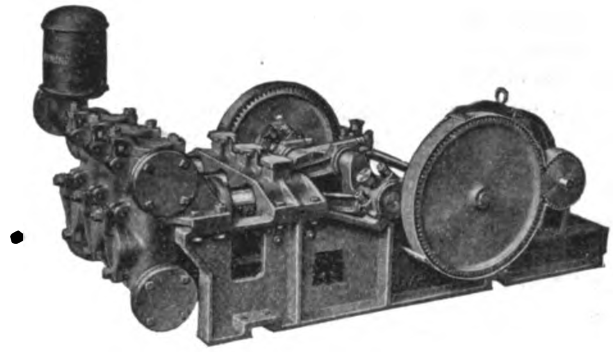


Fig. 73.

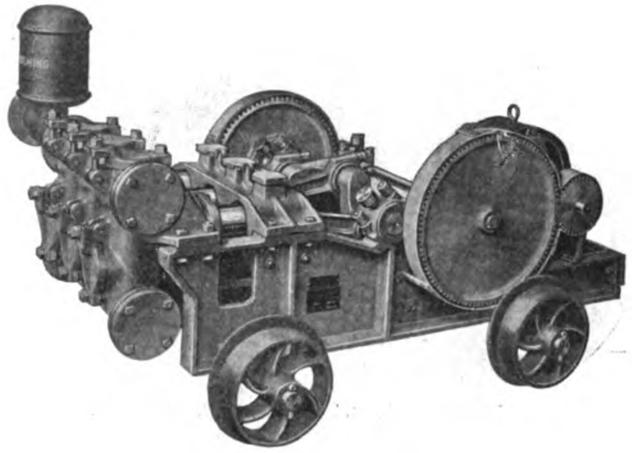


Fig. 72.

In designing these pumps, turns and angles have been eliminated as far as possible, insuring a straight flow of water through the cylinders and valve chambers.

This type of construction reduces the wear caused by the action of sulphurous or gritty water and is a point which will appeal strongly to practical pump men.

Figs. 72 and 73 are recommended for use where conditions are such that the pressure at the pump does not exceed 100 pounds.

The design has been made as simple as possible throughout, especial attention being given to accessibility and to the protection of the operator from injury.

Figs. 72 and 73 are the same in construction throughout, except that Fig. 72 is furnished with axles and wheels for tracks, the gauge of which is not less than 32-inches for the 4 x 5 size, 39-inches for the 5 x 6 size and 42-inches for the 5½ x 8 size. The side frames of Fig. 73 are also provided with slots to permit mounting on mine car axles when desired to be used as a portable outfit.

These pumps are also furnished when preferred, with a single reduction of gearing for connecting a **Slow Speed** motor instead of with double reduction of gearing as illustrated. The valve area is large, and yet the design is such that the clearance is reduced to a minimum, making the pump especially desirable for a gathering pump, as it readily frees itself of air.

Specifications:—

Crank Shaft is of best open hearth steel in one piece with flange for gear.

Gearing is machine cut, the motor pinion being of rawhide unless otherwise specified. **Gears Are Carefully Guarded.** The Crank Gear is bolted to the crank shaft and can be taken off without removing the shaft from its bearings.

Connecting Rods have babbitt lined adjustable boxes at the crank end and bronze bushings at the plunger end.

Plungers are of close grained iron unless otherwise specified, and the cross-heads reciprocate through bored guides.

Cylinders and Valve Chambers are unusually heavy for mine service and are provided with hand hole covers which give very quick access to valves.

Valves are of rubber on bronze grid seats which are screwed into decks.

Air Chamber, Grease Cups and Wrenches are furnished.

Special Construction: Pumps furnished with bronze, or brass-cased plungers, and bronze-lined stuffing boxes and glands when required.

Approximate Size of Motor Recommended

4 x 5— 5 h. p. motor.
5 x 6— 7½ h. p. motor.
5½ x 8—10 h. p. motor.

Figs. 72 and 73, Standard Sizes, Capacities, Etc.

Plungers		Capacities			Maximum Discharge Pressure Pounds	Diameter of Pipes		Cipher	
Diameter Inches	Stroke Inches	Gallons per Revolution	Usual Revolutions per Minute	Gallons per Minute		Suction Inches	Discharge Inches	Fig. 72	Fig. 73
4	5	.81	62	50	100	3	3	Ovate	Obole
5	6	1.53	66	100	100	4	3	Ouzel	Oby
5½	8	2.46	61	150	100	5	4	Otary	Ochry

Deming DOUBLE ACTING POWER PISTON PUMPS

FOR SERVICE AS GATHERING PUMPS

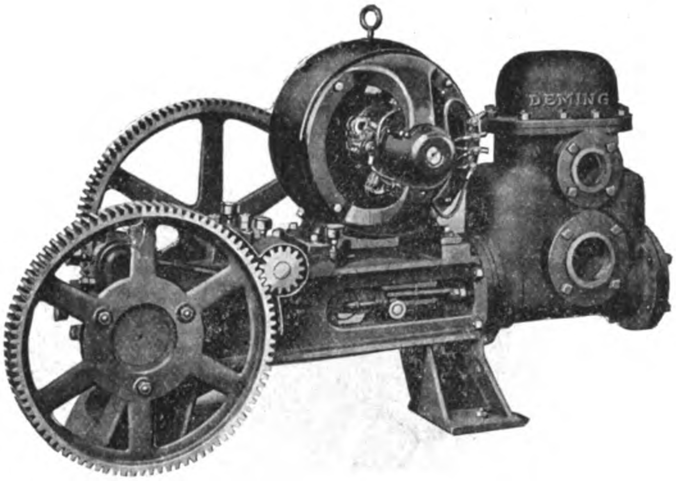


Fig. 716, "Ajax," with Type "BA" Drive.

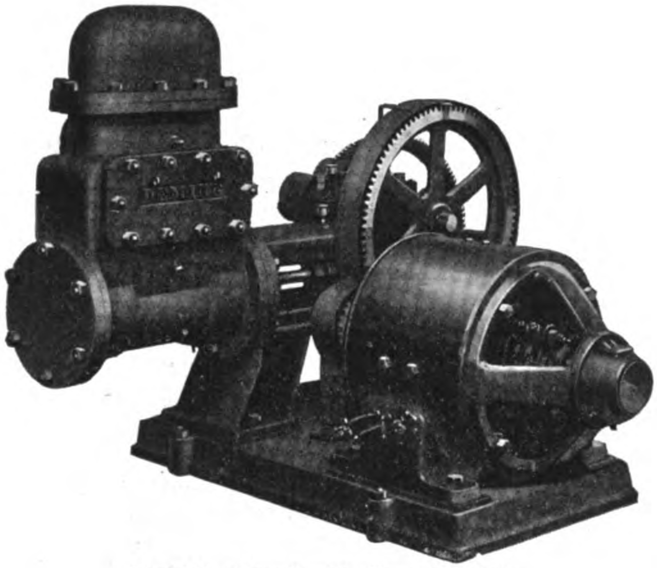
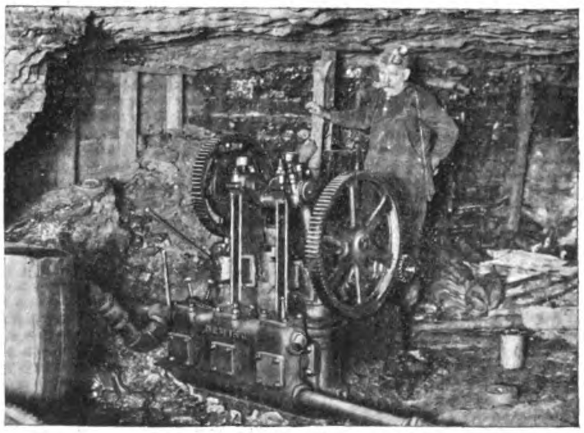


Fig. 716, "Ajax," with Type "B" Drive.



This Fig. 40 Deming Triplex Power Pump operating in the workings of the Norton Coal Mining Co. is illustrated and described on page ?????.

General Statement

The pumps illustrated on this and the opposite page are intended for use as gathering pumps for rooms, headings, etc., and are especially adapted for this service. They can also be used to good advantage for general water supply. They may be furnished with either brass lined cylinder or with solid bronze water end. **All gears are carefully guarded.**

Type "B" Drive includes sub-base on which both pump and motor are mounted and gearing connection between pump and motor.

Type "BA" Drive consists of pump with gearing connection for electric motor and with the main frame altered to permit of mounting the motor on top of pump, thereby economizing space. **We can furnish motor or gasoline engine if desired.**

The "Ajax" Fig. 716

Capacities: 30 to 215 gallons per minute.

Elevations: "Ajax" pumps are good for 75 to 150 foot heads, according to size.

Piston: Bronze cased; hemp packed. Piston rod, solid bronze.

Cylinder: Has heavy anti acid bronze liner.

Gears: Extra heavy. Cut from solid blanks.

Valves: Easily accessible. They are rubber on bronze grid seats which are screwed into the decks. Valve seats, stems and plates are anti-acid bronze.

Flanged Pipe Connections and heavy flanged removable air chamber. Below are given approximate sizes of motors recommended.

Size Cyl.	Motor	Size Cyl.	Motor
4x5	3 H. P.	6x10	7½ H. P.
5x5	5 H. P.	7x10	10 H. P.
5x6	5 H. P.	8x10	15 H. P.
6x6	7½ H. P.		

The above estimates are based upon 150-ft. total head.

Fig. 716, Sizes, Capacities, Etc.

Pistons		Cap. per Rev., Gals.	Revs. per Minute	Cap. per Min. at Max. Speed, Gals.	Diam. of Pipes	
Diam. Inches	Stroke Inches				Suction Inches	Dischg. Inches
4	5	.534	50 to 60	31.04	2	2
5	5	.833	50 to 60	49.98	2½	2
5	6	1.000	45 to 55	55.00	3	2½
6	6	1.448	45 to 55	79.64	3	2½
6	10	2.395	40 to 50	119.75	4	3
7	10	3.279	40 to 50	163.95	5	4
8	10	4.275	40 to 50	213.75	6	5

Gear Ratio 6 to 1.

Installation of Fig. 40 Deming Triplex Pump in Workings of Norton Coal Mining Co., Nortonville, Ky.

Mr. Sterling S. Lanier, Jr., Sec'y of the above Company, is highly pleased with the remarkable performance of this pump, about which he writes us as follows:

> "We have been using one of your Fig. 40 vertical triplex power pumps, 4 x 6, for over six years at various places in our No. 1 mine. For the last year, it has been pumping through 2" discharge, 1500 feet long, against a head of 60 ft. vertically. This pump runs continuously and is visited only twice each day for oiling. The gears have been renewed once in six years. Beyond this we have bought no repairs. We consider this a remarkable record."

The above letter is characteristic of hundreds of others in our files, testifying to the merits of Deming Mine Pumps.

DEMING

DOUBLE ACTING POWER PISTON PUMPS

FOR SERVICE AS GATHERING PUMPS

The "Vulcan," Fig. 604

Capacities: 13 to 65 gallons per minute.

Elevations: Good for 250 ft. head.

Cylinder: Has heavy brass liner.

Valves: Accessible without disturbing pipe connections. Valve areas are large.

Flanged Pipe Connections and heavy removable air chamber.

Fig. 604, Sizes, Capacities, Etc.

Pistons		Cap. per Rev., Gals.	Revolutions per Minute	Cap. per Min. at Max. Speed, Gals.	Diam. of Pipes	
Diam. Inches	Stroke Inches				Suction Inches	Dischg. Inches
3	4½	.263	40 to 50	13.15	1½	1¼
4	4½	.479	40 to 50	23.95	1½	1¼
5	6	.988	35 to 45	44.46	2½	2
6	6	1.436	35 to 45	64.62	3½	3

Gear Ratio 5 to 1.

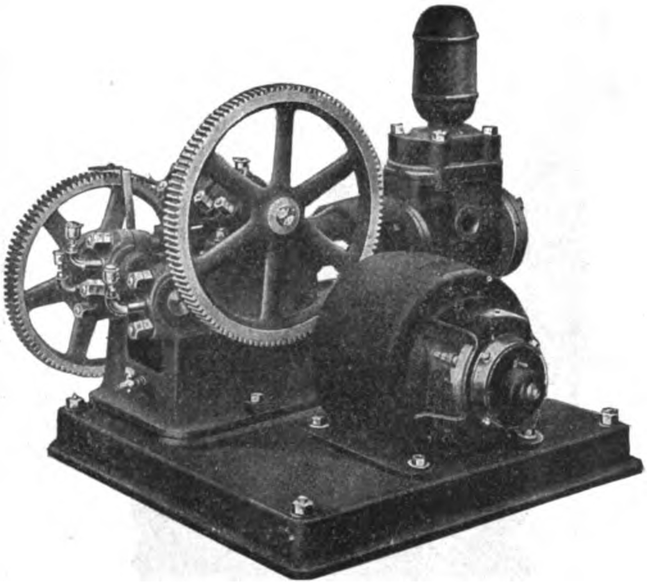


Fig. 604, "Vulcan" Electric Pump, with Type "B" Drive.

The "Neptune," Fig. 696

Capacities: 50 to 120 gallons per minute.

Elevations: All three sizes are good for 100 ft. head.

Cylinder: Has heavy anti-acid bronze liner.

Valves: Of the pot valve type. **Loosening two nuts** gives access. Valves are covered by anti-acid bronze plates which protect them from the cylindrically wound springs at the top.

Flanged Pipe Connections and heavy flanged movable air chamber.

Approximate sizes of motor recommended for use with the "Neptune," are given below:

Size Cyl	Motor
5x 5	5 H. P.
6x 6	7½ H. P.
6x10	7½ H. P.

The above is based upon a head of 150 feet.

Fig. 696, Sizes, Capacities, Etc.

Pistons		Cap. per Rev., Inches	Rev. per Min.	Cap. per Min. at Max. Speed, Gals.	Diameter of Pipes	
Diam. Inches	Stroke Inches				Suction Inches	Dischg. Inches
5	5	8.33	50 to 60	49.98	2	2
6	6	1.448	45 to 55	79.64	3	2½
6	10	2.395	40 to 50	119.75	4	3

Gear Ratio 6 to 1.

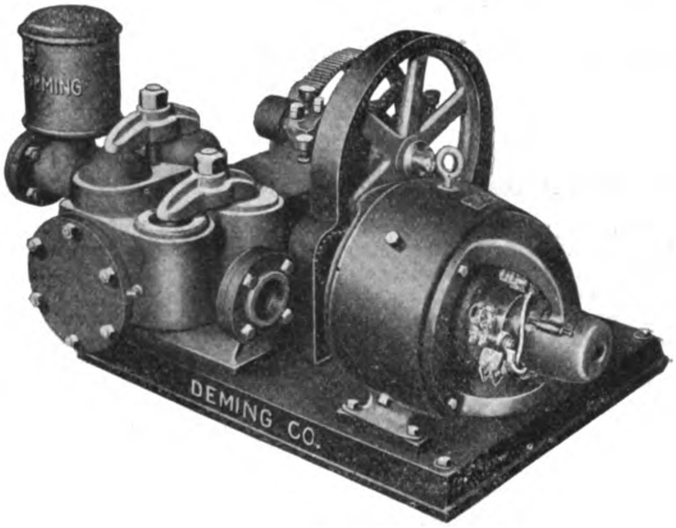
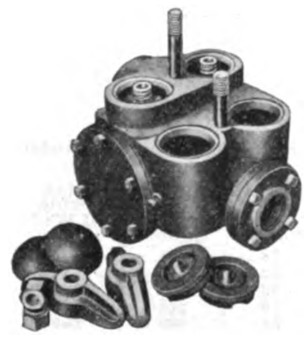


Fig. 696, "Neptune" Electric Pump, with Type "B" Drive.

Installation of Deming "Neptune" Pump at Smokeless Valley Coal Co., Johnstown, Pa.

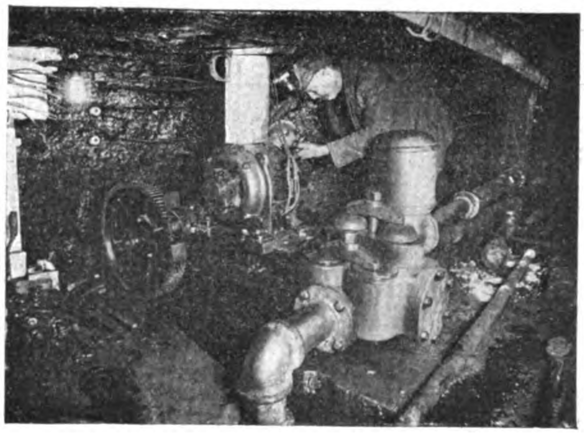


This shows how easy it is to "get at" the valves in the "Neptune."

The illustration opposite, shows a Deming "Neptune" pump which has been in service for four years in one of the Johnstown mines of the Valley Smokeless Coal Co.

Mr. C. C. Davey, General Superintendent, writes us about this pump as follows:

> "The cost of maintenance on these pumps has been remarkably low. Our attention is rarely directed to either of them, although they have been in **continuous service** since purchased and installed, four years ago."



Installation of Fig. 696 in Smokeless Valley Coal Co.

DEMING DEEP WELL WORKING HEADS

FOR GENERAL WATER SUPPLY

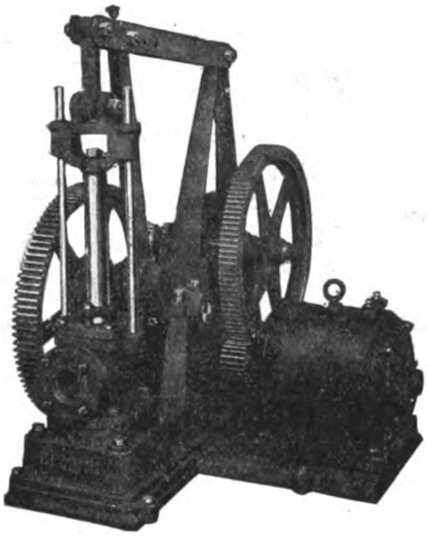


Fig. 62, 16-inch Stroke with Type "B" Drive.

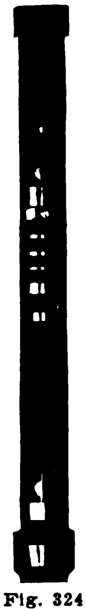


Fig. 324
Single
Acting
Brass
Deep
Well
Cylinder.

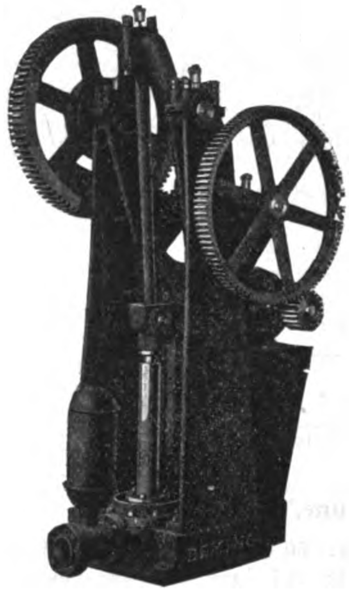


Fig. 80, 24-inch Stroke with Type "B" Drive

Fig. 62, with Differential Plunger

Fig. 62 is adapted especially for supplying water from deep wells when used in connection with one of our deep well cylinders. It is very substantially built, and the "low-down" design, as well as other features, make it the most accessible deep well pump on the market. By disconnecting the differential plunger from the crosshead and the walking beam from the connecting rod, and removing the stuffing box cap, the plunger can be readily withdrawn without disturbing the pipe connections. The stroke is adjustable, thereby permitting the easy regulation of the pump capacity to the flow of the water in the well.

Fig. 80, with Differential Plunger

This is a vertical type of working head, designed for use in wells up to 540 feet deep. Fig 62 (see illustration on opposite side of this page) is intended for use in wells up to 300 feet deep. We recommend that our Fig. 324 brass artesian well cylinder be used with these heads.

The illustrations represent the heads with Type "B" Drive, i. e., with sub-base and gearing connection for motor. Although motor is illustrated, it is not included in price on Type "B" Drive.

Fig. 62, Sizes, Etc.

Stroke Inches.	Maximum Diameter of Pipes		Gear Ratio.	Tight and Loose Pulleys.
	Suction Inches.	Inches. Discharge		
8, 9 and 10	4½	2½	6 to 1	16x3
12, 14 and 16	6	3	7 to 1	20x5
20, 22 and 24	8	4	6⅔ to 1	28x6

Fig. 80, Sizes, Etc.

Stroke Inches	Maximum Diam. of Pipes		Gear Ratio	Tight and Loose Pulleys
	Suction Inches	Dischg. Inches		
16	9	4	6 to 1	28x6
24	9	4	5¼ to 1	36x6

Fig. 62.

Maximum Speed and Capacity per Minute with Fig. 324 Cylinder.

Diam. Cyl. Ins.	10″ Stroke		16″ Stroke		24″ Stroke		*Max. Depth of Well Feet
	Rev.	Gals.	Rev.	Gals.	Rev.	Gals.	
2¾	40	10.2	35	14.3	28	17.2	300
3¾	40	19.1	35	26.7	28	32.1	175
4¼	40	24.5					190
4¾			35	42.9	28	51.5	130
5¾			35	62.9	28	75.4	120
6¾					28	104.	60
7¾					28	137.2	45

*Refers to vertical distance from lowest surface of water in well to highest point of delivery .

Fig. 80.

Maximum Speed and Capacity per Minute with Fig. 324 Cylinder.

Diam. of Cylinder Inches	16″ Stroke		24″ Stroke		*Max. Depth of Well Feet
	Revs.	Gallons	Revs.	Gallons	
4¼	35	34	28	41	540
4¾	35	42	28	51	450
5¼	35	52	28	63	360
5¾	35	62	28	75	300
6¼	35	74	28	89	250
6¾	35	86	28	104	210
7¾	35	114	28	137	150
8½	35	137	28	164	130

Deming HAND AND POWER PUMPS FOR VARIOUS USES

Deming "Peerless" Force Pumps for Deep or Shallow Wells

Fig. 281 Will Lift and Force 35 to 75 Feet

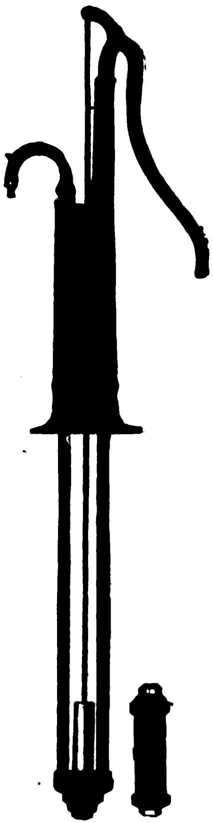


Fig. 281

This "Peerless" pump, Fig. 281, is a general favorite in coal mining communities. It is suited for wells 75 feet deep or less, provided a 2½" cylinder is used; with a 3" cylinder it is good for a 50 foot well; with 3½" cylinder for 35 foot well. Fig. 281 discharges water on each stroke and is an extremely easy pump to operate.

The complete line of "Peerless" pumps consists of 12 different pumps for shallow wells; deep wells; drilled wells; with hand top; with windmill top; with underground discharge. A special booklet will be sent on request, giving complete details of the "Peerless" pumps.

Hundreds of other Deming pumps for operation by hand, windmill or other power are shown in our 360-page General Catalogue No. 25.

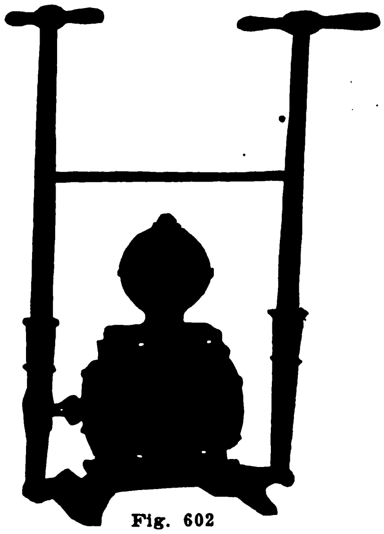


Fig. 602

Sizes and Prices, Fig. 281.

Fig.	No.	Diameter Lower Cylinder Inches	Fitted for Pipe Inches	Stroke Inches	Will Go In Drilled Wells Inches	Will Lift and Force Feet	Weight in Pounds	With Brass-Lined Cylinder	
								Cipher	Price
281	2	2½	1¼	6	5⅝	75	83	Barricade	$15.00
281	4	3	1¼	6	5⅝	50	86	Bastinado	15.00
281	6	3½	1½	6	6⅝	35	90	Bayonet	17.00

Deming "Triumph" Double Acting Force Pump, Fig. 602

This is a heavy, double acting force pump with two malleable iron levers and is well adapted for mine service. Piston is brass. Valves and seats are brass. Cylinder is brass lined. All brass cylinder, or entire water end of brass furnished when specified, at extra cost. Brass vent plug is provided to prevent freezing.

Suction and discharge are regularly fitted for iron pipe. Brass hose couplings furnished at extra price. **Extreme suction lift should not exceed 25 feet.** Fig. 602 is good for 50 pounds pressure.

Sizes and Prices, Fig. 602.

Fig.	No.	Diam. Cyl. In.	Length Stroke, In.	Gals. per Rev.	Diam. Suc. Pipe, In.	Diam. Dis. Pipe, In.	Brass Lined		Brass Cylinder		*Brass		Extra for Brass Hose Coupling
							Cipher	Price	Cipher	Price	Cipher	Price	
602	3	4	4½	.490	1½	1¼	Facingly	$35.00	Fact	$ 65.00	Facto	$ 95.00	$3.00
602	4	5	5½	.935	2	1½	Fagging	45.00	Failing	95.00	Factum	155.00	4.25
602	5	6	5½	1.224	2½	2	Fagot	55.00	Fainted	125.00	Factual	190.00	7.50

*Brass pumps are made entirely of brass, except levers, links and bolts.

Deming "Straight Line" Working Head, Fig. 1717

This head may be operated by hand, windmill, gasoline engine or electric motor. We recommend the use of our Fig. 322 brass tube cylinder (see illustration) in connection with Fig. 1717.

The pump jack is cast as a part of the head, insuring permanent alignment of all parts. A separate flange supported by the base is provided for attaching drop pipe.

When head is to be operated by hand or windmill the cross head pins should be removed which permits the connecting rods to drop out of the way.

This is a substantial head, built for long, and hard service. A special bulletin showing several different adaptions of Fig. 1717 will be sent upon request.

In our complete 360-page General Catalogue, hundreds of hand and power pumps for all pumping requirements are illustratedand described.

Sizes and Prices, Fig. 1717.

Largest Drop Pipe Inches	Back Outlet Inches	Stroke Inches	Gear Ratio	Tight and Loose Pulleys	Dimensions of Base Inches	Approx. Weight Pounds	Cipher	Price
3	2	6-8-10	6-1	14 x 3	10 x 16	235	Obit	$45.00

Maximum Speed and Capacity Per Minute with Fig. 322 Cylinder.

Diameter and Stroke of Cylinder, Inches	Gallons per Revolution of Crank Shaft	Maximum Revolutions per Minute	Gallons per Minute	Maximum Lift in Feet Surface of Water to Point of Discharge
2¼ x 10	.172	40	7	300
2¾ x 10	.257	40	10	190
3¼ x 10	.359	40	14	140
4 x 10	.544	40	21.7	90

Fig. 322, 2¼"x16" with "J" Plunger

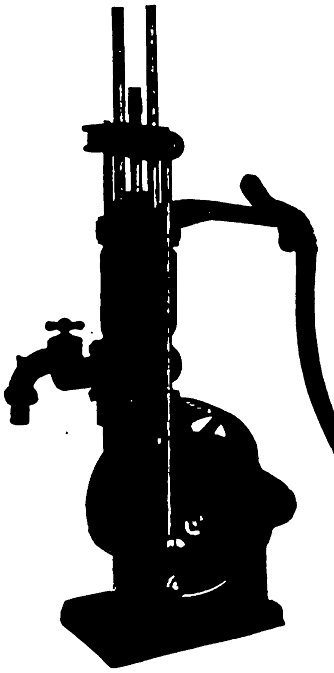


Fig. 1717

All prices are list and subject to discount.

DRAVO-DOYLE CO.

Main Office

PITTSBURGH, U. S. A.

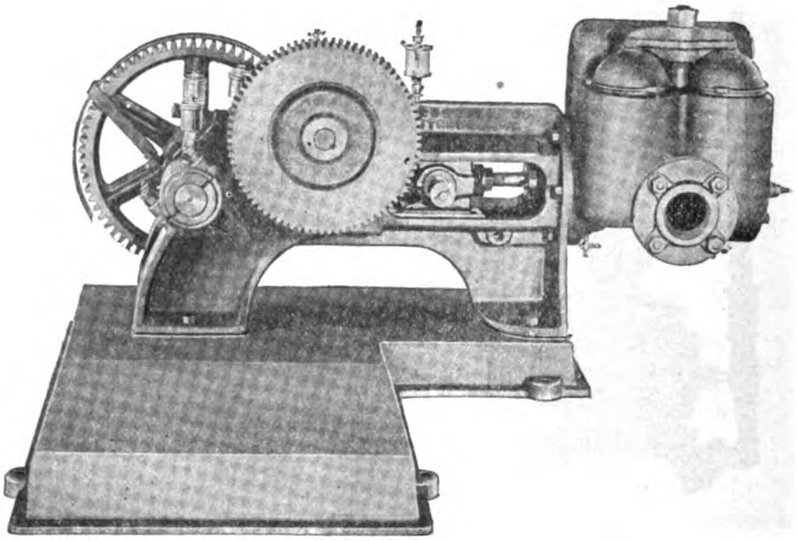
PHILADELPHIA CLEVELAND INDIANAPOLIS

Manufacturers of the

Austin Mine Pump

(PATENTED)

A Pump the Mine Man Needs



Power Frame

The frame is a heavy webbed casting, cast solid, bolted to the bed plate and to the water box. The guides are bored from the solid casting to give perfect alignment. The crosshead is of the box type with adjustable wearing shoes; the shaft is solid forged steel. The connecting rod is steel, the cross head end solid type with bronze boxes, at the crank end marine type, babbitt lined. The gears are of cast iron, and protected by guards. The pinion is forged steel, machined cut (and heat treated).

The motor spur is of the weighted fly-wheel type, having a storage of power in the rim which prevents the shock of the pump stroke being transmitted to the motor. This gives greater efficiency.

Water Box Construction

The water ends are of cast iron or of our special anti-acid metal, as conditions may require. All cylinders are fitted with anti-acid removable cylinder bushings, piston and follower, rod and rod box, valve seats and valve stems. It is cast solid and bolted rigidly to the power frame. It is provided with flange unions for connecting the pipes, and with drain plugs for draining the cylinder and valve chamber.

Water Box Design

The design of the Austin water box is a patented feature, devised to prevent the shock from the piston stroke being brought onto the discharge line. The reduction or elimination of waterhammer is an additional safety factor.

The accessibility of the valves is also a feature of the Austin Pump. It is necessary to remove **but one nut** to expose all valves. Hence this pump can be cleaned more quickly and more thoroughly than any other pump. This makes it ideal for working near the face, where small particles of coal are likely to be picked up and may lodge in the valve chamber.

Drive

The bed plate of the pump is designed to carry the motor as well. We supply the motor regularly, (or) it can be supplied independently. In case we supply it, it is necessary that we know the kind of current (A. C. or D. C.) available, and the voltage, as well as the vertical head, and the size and length of the pipe line.

Sizes

The Austin Pump is made in two sizes as follows:

Size 4 by 5. Capacity 30 to 50 gallons per minute, 2½-inch suction and discharge.

Size 5 by 6. Capacity 60 to 80 gallons per minute, 3-inch suction and discharge. (5 by 6 size supplied with removable bearings.)

Established 1877

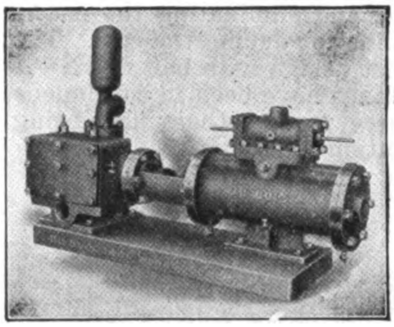
DUBOIS IRON WORKS

DUBOIS, PA

Manufacturers of

STEAM PUMPS, MOTOR DRIVEN PUMPS, BELT DRIVEN PUMPS and GASOLINE ENGINES

Dubois Steam Pumps



They have been designed with a view of furnishing a Mine and Boiler Feed Pump that will give the greatest efficiency, yet having the fewest possible number of working parts that will be subject to wear or breakage.

The working parts of the steam end consist of the steam piston and a single piston valve which are entirely automatic in operation, the steam pressure being the only propelling force.

The steam entering the valve chest passes immediately to the cylinder through the main port, forcing the piston the full length of its stroke and past a port leading to a by-pass that carries the steam to the opposite end of the valve, pushing it forward, thereby reversing the stroke.

The operation of the valve is thus fully assured, but at no time can it open or let steam into the opposite end of the cylinder until the piston has completed its full working stroke. This principle assures that the pump will do its full duty and work at a uniform capacity.

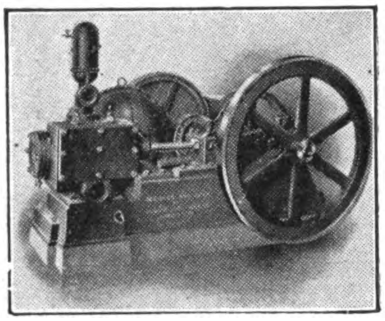
Our efforts for "simplicity" have not been confined alone to the steam end of our pumps, but every working detail of the water end as well has been carefully thought out as regards simplicity, effectiveness and ease of access.

The water valves number four or more, according to the size of the pump. Two valves are operated on one stem arranged one above the other, so that by unscrewing the plug on top of the valve chest and drawing out the stem both are released. The valves are made with extended guides, which assures even wear and square seating and affords perfect alignment. They are also instantly accessible for inspection on removing the flat side plates and without interfering in any way with the pipe connections or air chamber.

Motor Driven Pumps

Motor Driven Pumps offer many advantages and for some work are recommended as being more desirable than steam pumps. This particularly holds good where long transmissions of steam are entirely impractical, owing to the great losses due to condensation.

A Motor Driven Pump can be placed at any distance from the central power station and operated with maximum efficiency.



The dubois is extremely simple in design. The water cylinder is the same as used on our Steam Pumps and is operated from the motor through intermediate spur gearing, a crank shaft and connecting rod. All gears are cut and will therefore operate with the least possible friction and noise.

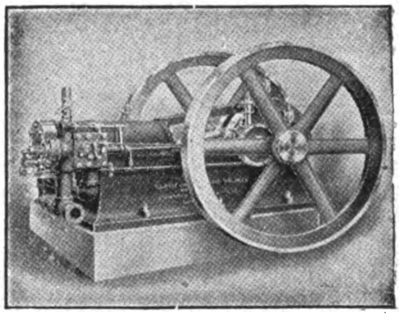
To give perfect alignment between pump and motor the complete outfit is mounted on a cast iron base, giving substantial foundation for the motor crank shaft and gearing.

Belt Driven Pumps

Bubois Belt Driven Pumps are the result of years of experience in pump building and the same careful attention to detail in design that characterizes all Dubois products. It is of the same general construction as our Motor Driven Pumps, the only difference being that it is equipped with belt pulleys in place of main drive gear. It will be found a thoroughly dependable pump for the most severe service.

Gasoline Engines

The essentials for a practical and durable gas or gasoline engine are simplicity of design, perfectness of construction, absolute governor control and sufficient weight to withstand the continuous high pressure of explosions they are subjected to.



In designing the Dubois these features have been closely maintained regardless of expense, and the finished product stands out prominently in compactness, simplicity and weight over other makes.

When in need of a Gosoline Engine to operate a Pump or Fan, or for other power about your mines, investigate the Dubois, paying especial attention to the valve operation, governor, auxiliary exhaust and igniters, as these are important points to consider in the selection of an engine.

G. H. ELMORE

ELMORE PHILADELPHIA SCRANTON ELMORE

Engineer

Somers, Fitler & Todd, Pittsburgh Agents
Manufacturer of

Elmore Continuous Centrifugal Coal Dryer & Acid-Resisting Centrifugal Pumps

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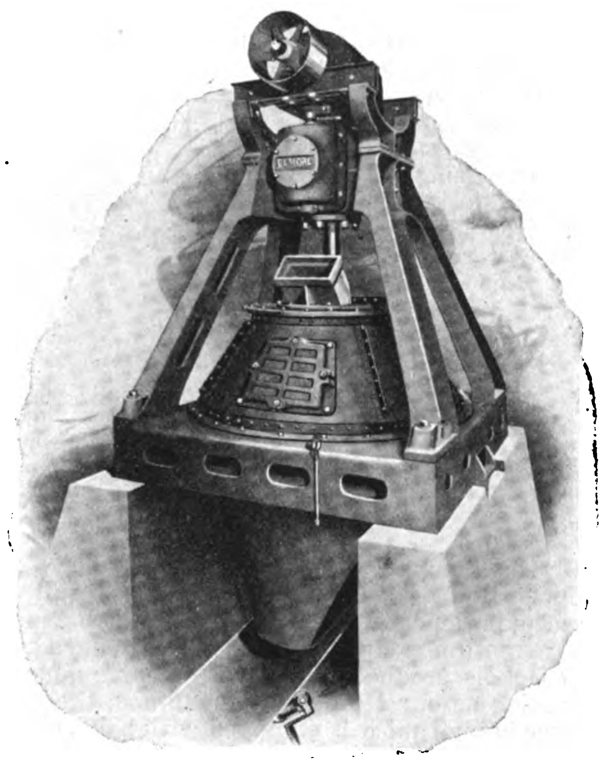
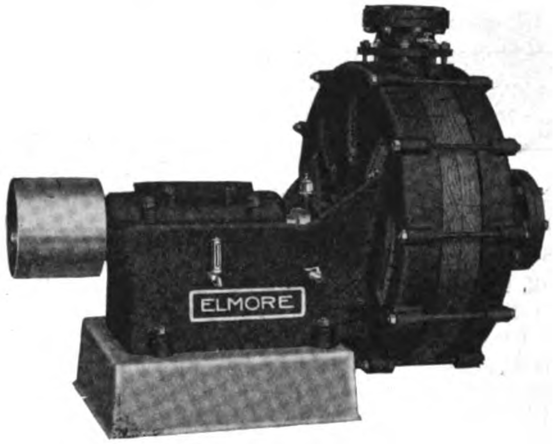


Elmore continuous Centrifugal Dryer for drying fine washed coal. Capacity up to seventy-five tons per hour.

Centrifugal Coal Dryer

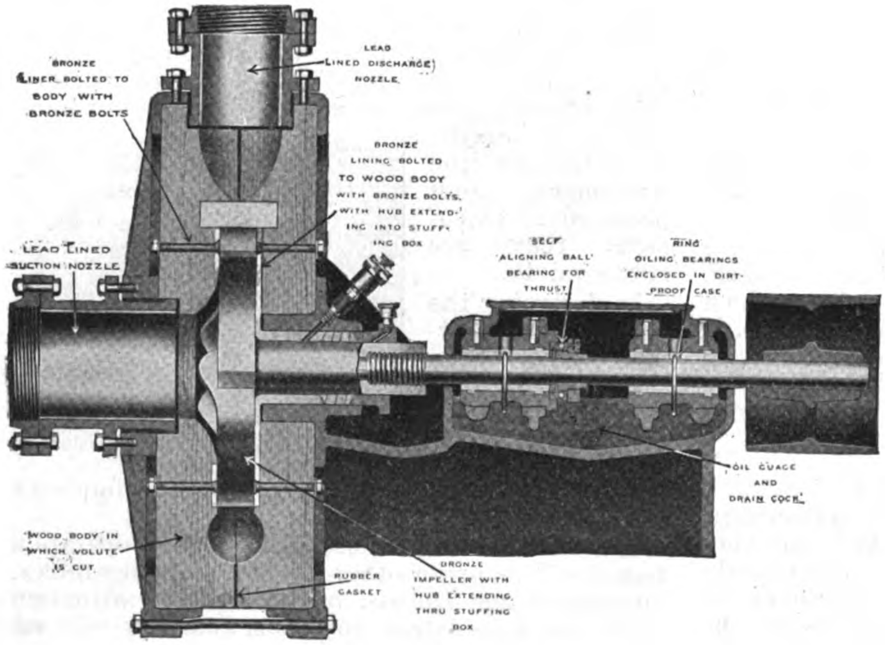
For instantly removing the moisture from washed coal, permitting immediate charging to coking ovens. Furnished with either belt or direct connected motor drive, and eliminating the necessity of large storage bins for drying the coal. The illustration shows latest design with belt drive. A number of these machines have been in continuous operation for over three years; others now being erected. Full information on request.



Elmore Pump Complete.

Acid Resisting Centrifugal Pump

This pump is particularly adapted to handling acid mine water through any lift where a single stage centrifugal of best design and efficiency is applicable. It is particularly useful for circulating water in coal preparation plants, pumping slush, etc. Study the cross section and note how the volute is cut from solid, non-rotting wood, and how all the main parts of the pump never come in contact with the bad water, and are therefore not affected by it. A fully illustrated bulletin with tables of capacity, R. P. M. and H. P. required for all sizes from 1½" to 12" discharge, showing capacities up to 4,500 gal. per minute, may be had for the asking. A large number of these pumps have been in constant use for nearly four years. In all details of construction the pump could not be better built.


BRONZE LINER BOLTED TO BODY WITH BRONZE BOLTS
LEAD LINED DISCHARGE NOZZLE
BRONZE LINING BOLTED TO WOOD BODY WITH BRONZE BOLTS, WITH HUB EXTENDING INTO STUFFING BOX
LEAD LINED SUCTION NOZZLE
SELF ALIGNING BALL BEARING FOR THRUST
RING OILING BEARINGS ENCLOSED IN DIRT-PROOF CASE
OIL GUAGE AND DRAIN COCK
WOOD BODY IN WHICH VOLUTE IS CUT
RUBBER GASKET
BRONZE IMPELLER WITH HUB EXTENDING THRU STUFFING BOX

An X-Ray of the Elmore Centrifugal Pump.

EPPING-CARPENTER PUMP CO.

ESTABLISHED 1866.

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Manufacturers of Steam, Power & Centrifugal Pumps

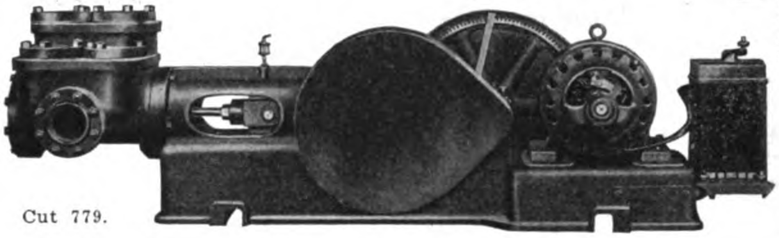
HIGH DUTY PUMPING ENGINES AND CONDENSERS

We have complete line of patterns for every condition of service for Mine Work, including steam driven pumps with simple, compound and triple expansion steam ends, equipped with all accessories and jet condenser.

Epping-Carpenter Bull Dog Electric Driven Mine Gathering or Dip Pump

Points of Superiority:

1. Bearings twice the size of those ordinarily used.



Cut 779.

2. 5x6 size built to pass through space 2′6″ wide x 33″ high, from top of rails.

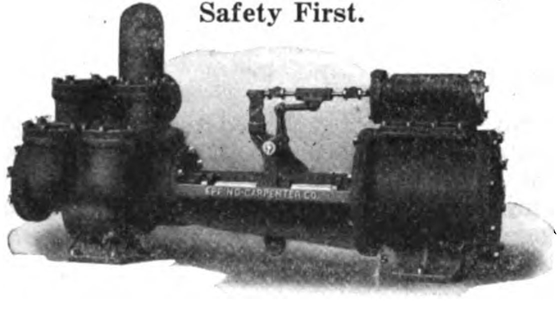
3. No car necessary; use two square axles and four car wheels. Base made with slots so that same can be dropped down over axles and positively secured.

4. Liners, valve seats and all other bronze parts cast of anti-acid mixture containing no zinc. Complete water cylinder can be made of this bronze if desired.

5. Will take any make of motor without change of frame or base.

6. Water cylinder castings double the usual thickness to resist corrosion from bad mine water.

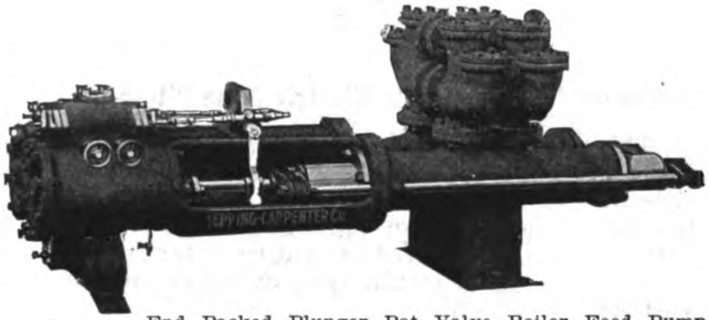
7. All gears totally enclosed. Safety First.



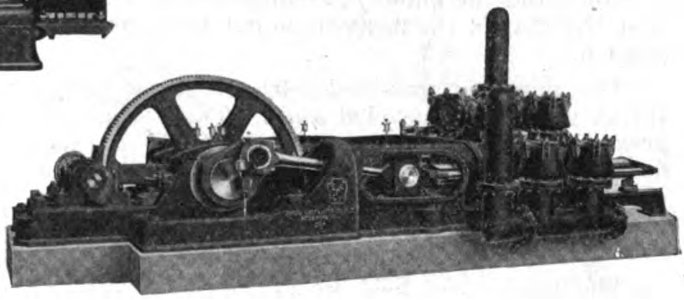
Cut 603—Epping-Carpenter Steam Actuated Mine Gathering or Dip Pump.

Send for Special Bulletin giving full list of sizes, etc.

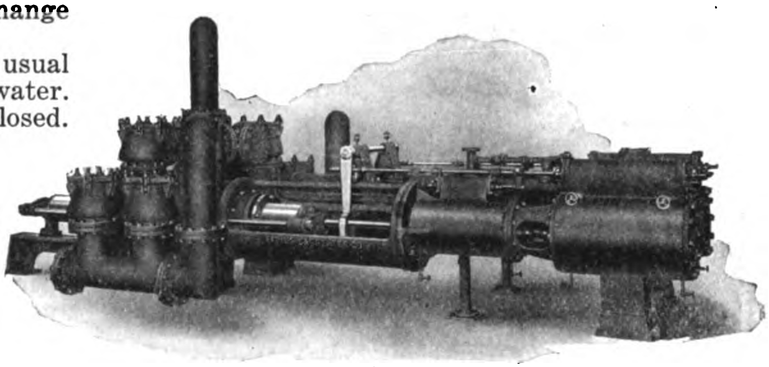
Fifty-one Years in Business.



End Packed Plunger Pot Valve Boiler Feed Pump with Patented Balanced Piston Steam Valves and Outside Lost Motion Adjustment. Large sizes furnished with Compound Steam Cylinders.



High Efficiency Electric Driven, Wood Lined, Mine Pump, equipped with Herringbone Gears.



Steam Driven, Wood Lined, Mine Pump. Compound Steam Cylinders with Piston Valves.

Send specifications, giving conditions of service, and we will submit proposition with recommendations for machinery for your service.

Over 16,000 Pumps in Service.

FAIRMONT MINING MACHINERY CO.

Regular Equipment.

Tipple Structures
Screens and Chutes
Loading Booms
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FAIRMONT
(The Mark of Quality.)

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Steel Mine Ties
R. R. Car Retarders
Portable—
Electric Mine Pumps
Power Coal Augers
Box Car Loaders
Mine Car Trucks

COAL MINE EQUIPMENTS

Fairmont No. 5 Portable Electric Mine Pump

This machine is the result of years of experience in pump building and embodies many of the features that insure effectiveness and reliability. The pump is of the outside end packed plunger type, but if this type is not desired the entire water end may be removed and a piston type of water end substituted.

Construction

All moving parts of the pump are entirely enclosed except the plunger. The glands are removable, and the gland fastenings are so designed that the glands themselves cannot be improperly aligned.

The pump is provided with stemless bronze valves working in beveled seats. These seats are pressed into place, being provided with a taper fit. The suction valves are seated in the valve cap plate, while the discharge valve seats are in a removable plate held between the cap and the cylinder casing.

The valves are held in a yoke, the point of contact between yoke and valve cap being a pivoted stud upon which the yoke is free to rotate. This type of fastening is of great advantage when access to the valve chamber is necessary for inspection or repair.

Lubrication

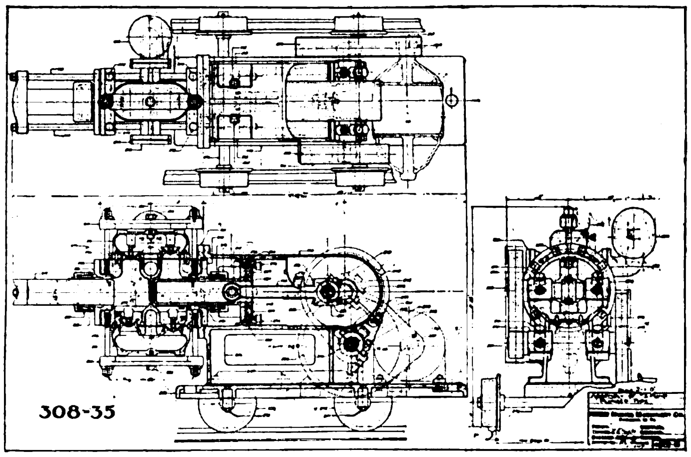
The pump is provided with grease cups for lubrication with greases, the cups being protected by housings. If it is wished to lubricate with oil, the cups may be removed, in which case the housings are used to hold waste.

Removable Bearings

All bearings are die cast. They may consequently be removed without disconnecting the pump from either suction or discharge line. The die casting insures perfect alignment of the shafts and bearings.

When the bearings of a pump of this kind are of babbitt or other heating metal cast into place they are often allowed to wear down for a considerable distance before repairs are made. With the die castings, on the other hand, the replacement of a worn bearing is a matter of only a few minutes time, and the pump is consequently more likely to be kept in good repair, than when new bearings must be cast into place.

By this means also, one man is able to carry all the bearings necessary for the pump with him into the mine and put them in place. This is a very great advantage over the case in which it is necessary to break connections and transport the pump to some point where babbitt can safely be melted and poured.



Sizes and Capacity

The No. 5 pump is designed to pump 100 gal. per minute against a head of 100 feet. The plungers are — inches, with a —inch travel. The overall minimum height is 41 inches, the minimum track gage 30 inches.

Motor

The motor used may be any motor of standard characteristics, for either direct or alternating or direct current, and may be equipped to be self-starting.

PUMPS

Fairmont No. 1 Portable Electric Mine Pump

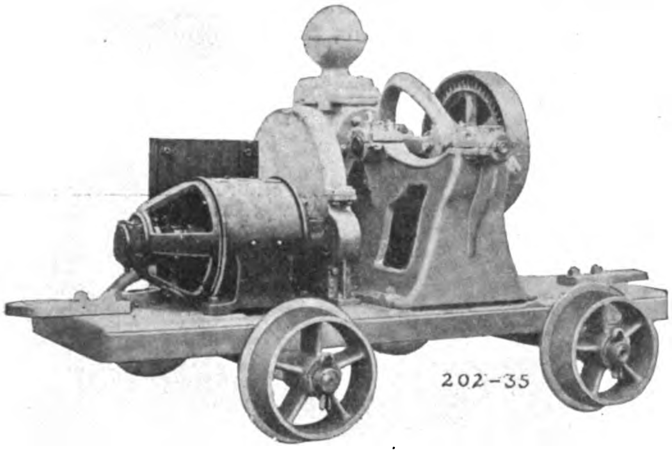
This is, by all means, the neatest and cheapest outfit on the market today, and you cannot afford to miss the opportunity to give it a trial.

We are the originators of the Mounted Electric Portable Pump for gathering purposes in coal mines. They are not an experiment with us. The capacity and quality are unequalled at the price, and more gallons are pumped per dollar of expense for power and repairs.

The illustration below shows an ideal outfit for mine use—mounted, portable, electrically operated. The total weight, including axles and wheels, is only 1,500 lbs., and exclusive of wheels and axles 1,100 pounds. For semi-permanent service it can easily be lifted off the axles and set to one side.

Construction

The pump and all parts are strongly constructed throughout, especially for mine service, as the following list will show, and are put out under our usual guarantee of satisfaction or no pay.



Special Features in "Fairmont" Pump

Crank Shaft—steel, drop forged.

Yoke—cast steel, annealed.

Connecting Rod—malleable iron, brass bushed on both ends.

Piston Rod—bronze, with bronze nuts.

Cylinder Liner—¼-inch thick, acid-resisting bronze.

Valves—acid-resisting bronze.

Valve Seats—acid-resisting bronze.

Stuffing Box—acid-resisting bronze.

Drain Plugs—acid-resisting bronze.

Plunger Irons—acid-resisting bronze when conditions require.

Standard Irons—are cast iron.

Motor Pinion—forged steel, cut teeth.

All Other Gears—cast iron with cut teeth.

All gears and pinions completely enclosed **SAFETY FIRST.**

Gears—are properly guarded.

Bearings—are cast babbited with oil chamber, thus eliminating the use of oil cups, which are always easily broken off.

Bronze Water End—complete for severe conditions.

Motor—two or three H. P., as desired by purchaser, any voltage.

Fairmont Bronze

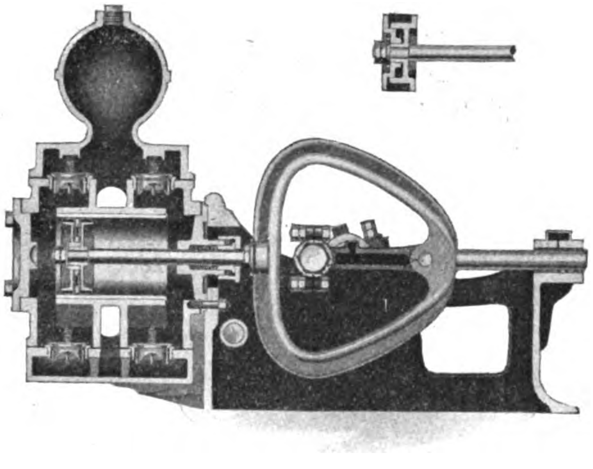
For the purpose of comparison, samples of several acid resisting bronzes were immersed in 10% sulphuric acid solution for 20 days, with results as follows:

Material	Weight of sample in Grams	Loss in Weight in Grams	Loss %
Fairmont Bronze	137.6400	0.1756	.128
A.........Metal	131.5405	0.3541	.269
B.........Metal	124.2405	0.4071	.376

This table shows that for acid resisting qualities the Fairmont Bronze, used in our liners, valves, valve-seats, etc., is over 200% better than the second sample, and 300% better than the third sample. It is this careful selection of materials that makes Fairmont Pumps superior to all others.

Size and Capacity

The pump sizes are as follows: 5-inch cylinder, 4½-inch stroke, 2½-inch suction, 2-inch discharge, with a capacity of 30 to 60 gal. per minute.



Over-all height above top of rail is 41 inches with 14-inch wheel, and with 10-inch wheels, 39 inches.

Motor

We use General Electric Type R. C. or C. V. C. Self-Starting motors, and no starting box is needed. Whenever the power goes off for a few minutes it is not necessary, with this arrangement, to send a man to start the pump when the power somes on again. Any mine superintendent can appreciate this convenience.

THE GOULDS MANUFACTURING CO.

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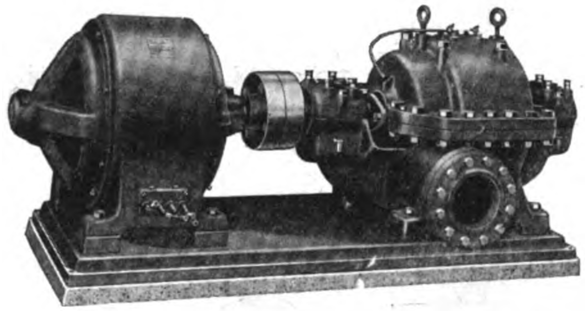
Products

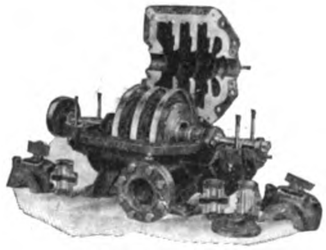
No. 100. Double-Acting, Single-Cylinder Piston Pumps.
No. 101. Single-Acting Triplex Plunger Pumps, Outside-Guided Type.
No. 102. Single-Acting Triplex Plunger Pumps, Trunk Plunger Type.
No. 103. Single-Acting Triplex Plunger Pumps, Large Capacity and High Pressure Types.
No. 104. Double-Acting Triplex Piston Pumps, Vertical Type.
No. 105. Single-Stage, Single Side Suction Centrifugal Pumps.
No. 106. Vacuum and Stuff Pumps.
No. 107. Deep Well Triplex Pumps.
No. 108. Deep Well Working Heads and Cylinders.
No. 109. Portable Mine Pumps.
No. 110. Single-Stage, Double-Suction Centrifugal Pumps.
No. 111. Centrifugal Sump Pumps.
No. 112. Handy Data on Power Pumping.
No. 113. Rotary Pumps.
No. 114. Vertical Single Stage Centrifugal Pumps.
No. 115. Double-Acting Triplex Plunger Pumps, Horizontal Type.
No. 116. Single-Acting Triplex Pressure Pumps.
No. 117. Air Pressure and Vacuum Pumps.
No. 118. Centrifugal Fire Pumps.
No. 119. Single-Stage, Single-Suction Centrifugal Pumps, Enclosed Impeller Type.
No. 120. Multi-Stage Centrifugal Pumps for General Service.
No. 121. Diaphragm Pumps.



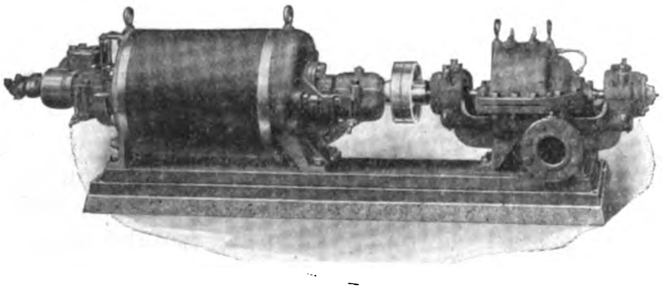
Goulds Fig. 3300 Multi-Stage Centrifugal Pump Connected to Electric Motor.

Fig. 3300 is a multi-stage centrifugal pump suitable for elevations up to 580 feet. Built for capacities from 50 to 1,500 gallons per minute. Described in Bulletin No. 120.

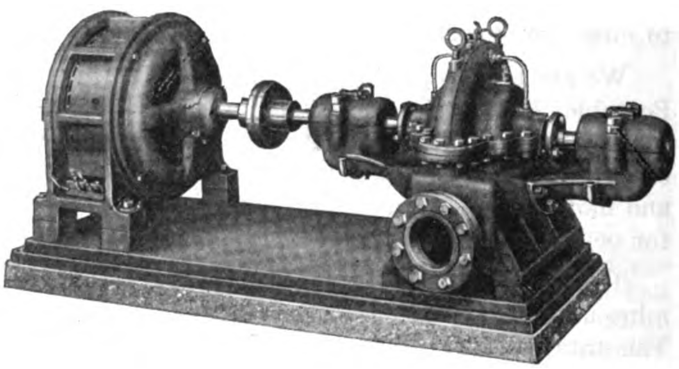
Fig. 3300 with top half of casing raised. Note that bearings can be removed without disturbing the pump shaft.



Goulds Fig. 3300.



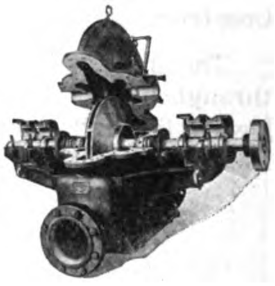
Goulds Fig. 3300 Multi-Stage Centrifugal Pump Connected to Steam Turbine.



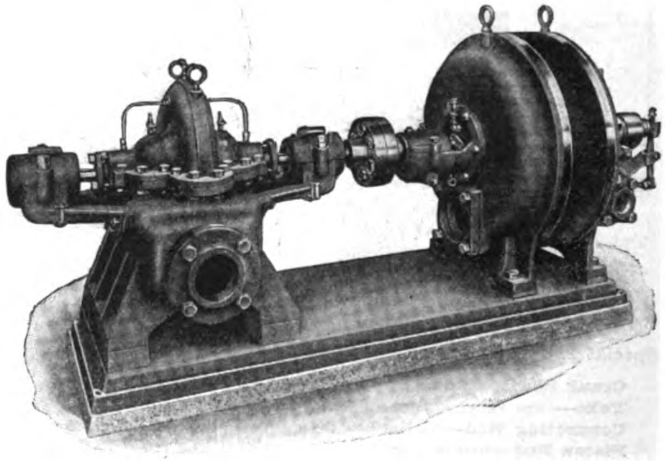
Goulds Fig. 3030 Double-Suction, Single-Stage Centrifugal Pump Direct Connected to Electric Motor.

Fig. 3030 is a high-grade single-stage double-suction centrifugal pump for elevations up to 150 feet. Built for capacities from 80 to 8,000 gallons per minute. Described in Bulletin No. 110.

Fig 3030 with top half of casing raised showing accessibility of interior of the pump.

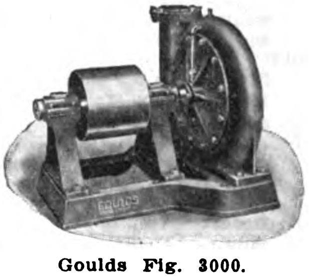


Goulds Fig. 3030.

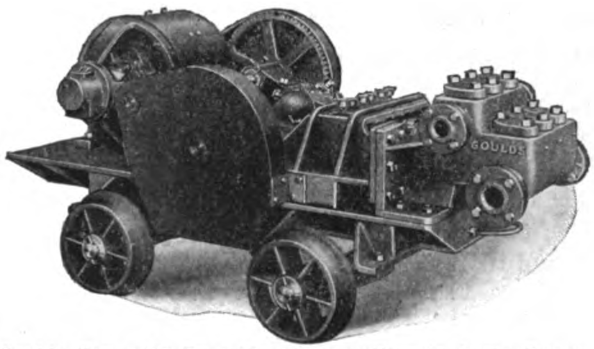


Goulds Fig. 3032 Double-Suction, Single-Stage Centrifugal Pump Direct Connected to Steam Turbine.

Fig. 3000 is a single-stage, side suction centrifugal pump, suitable for elevations up to 100 feet. Built for capacities from 20 to 5,000 gallons per minute. Can be furnished with pulley as shown or for direct connection to motor. See Bulletin No. 105.

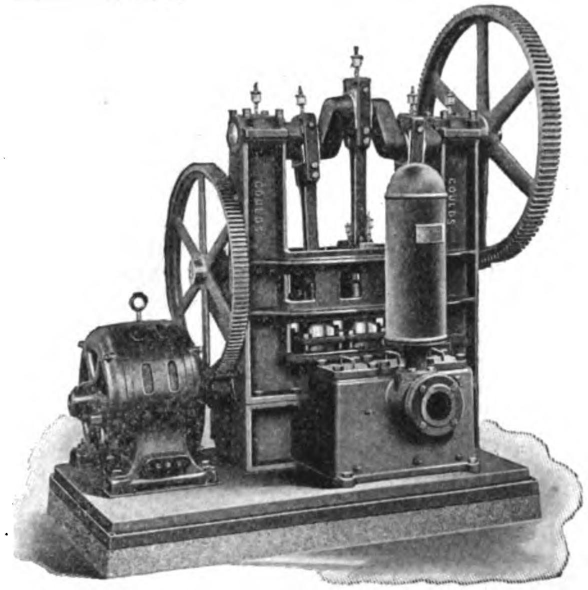


Goulds Fig. 3000.



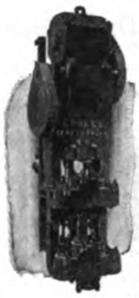
Goulds Fig. 1637 Portable Triplex Electric Sump Pump.

This pump is mounted on an all-iron truck with adjustable axles, which can be used on any gauge track. For heads up to 500 feet. Capacity 65 gallons per minute. Can be used as a station pump by mounting on bed-plate instead of on truck. Bulletin No. 109.



Goulds Fig 1009 Single-Acting Triplex Pump with Gear Connected Motor.

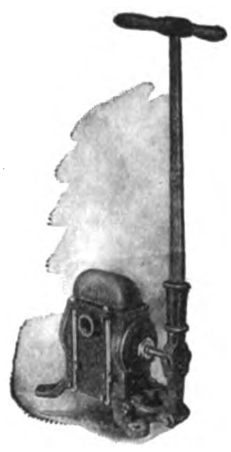
This is a small and moderately large capacity type for unwatering mines, suitable for elevations up to 350 feet. Built for capacities from 2 to 350 gallons per minute. See Bulletin No. 101.



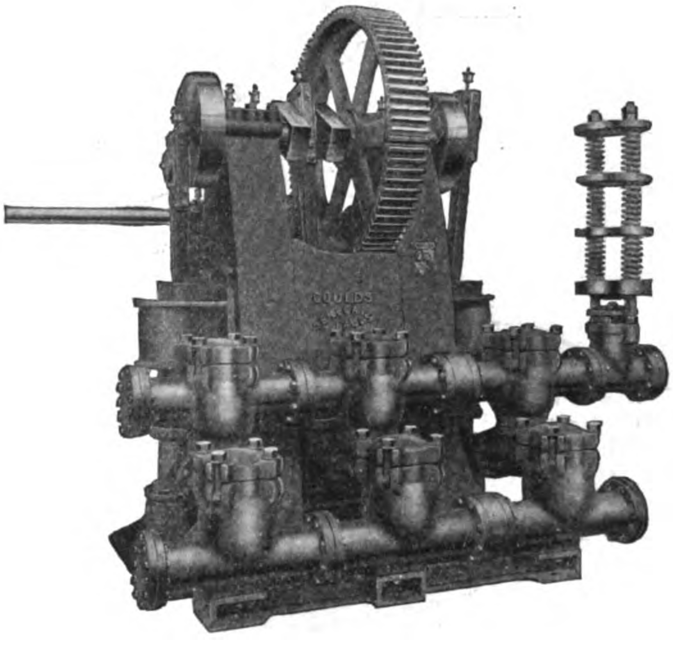
Goulds Fig. 1237 Duplex Electric Sinking Pump.

Fig. 1237 is a sinking pump for service in mine shafts. All parts are so protected that the pump will withstand very hard usage. Frame is provided with wrought iron hanging bars for suspending the pump in the shaft. Bulletin No. 109.

Fig. 470 is a type of hand pump used largely in mines for supplementary service. Made in five sizes with capacities from .19 to 1.28 gallons per revolution. Will lift and force 100 to 150 feet. Can be furnished with two handles if desired.



Goulds Fig. 470 "Challenge" Double-Acting Force Pump.



Goulds Fig. 1585 Single-Acting Triplex Pump.

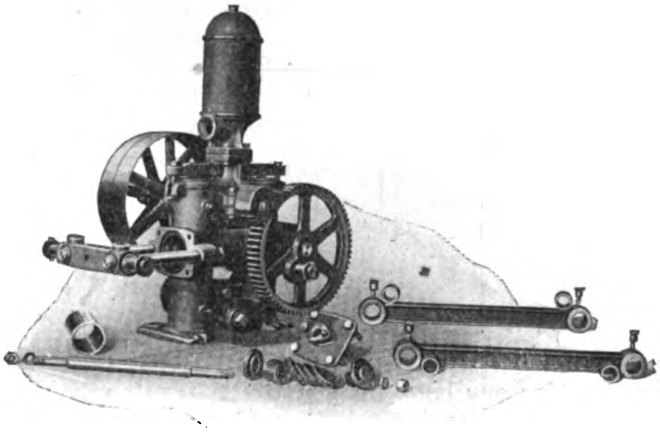
Fig. 1585 is a high pressure type for elevations of 230 to 3,500 feet and for capacities from 51 to 1,152 gallons per minute. Described in Bulletin No. 103.

Fig. 1678, illustrated below, is a single-cylinder, double-acting piston pump, same as the well-known Fig. 1531 except that the cylinder is fitted with a renewable cast bronze lining and the piston is furnished fibrous packed only.

Suitable for elevations up to 200 feet. Built in five sizes for capacities from 5 to 50 gallons per minute.

Can be furnished with tight and loose pulleys for belt drive as shown or arranged for geared connection to motor.

This pump is described in Bulletin No. 100.



Goulds Fig 1678 "Pyramid" Double-Acting Piston Pump.

HARRIS PUMP & SUPPLY CO.

320-322 Second Ave. PITTSBURGH, PA.

Pumps ane Hydraulic Machinery

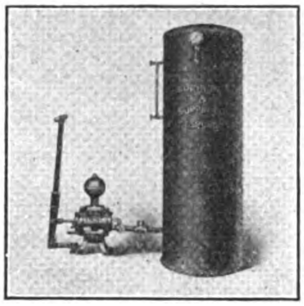
Harris Water Supply Systems and Steam Pumps

For Prompt Shipment

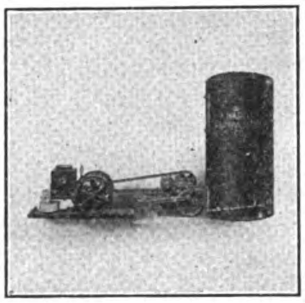
Harris Water Supply Systems

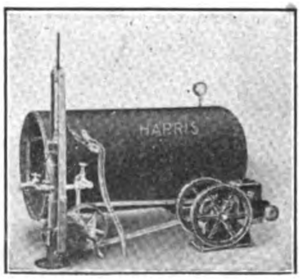
Adequate water supply around the mine is a necessity.

Illustrations, showing outfits No. 2, No. 33 and No. 38, are the smaller outfits for private family use. He have outfits, however, for giving you a water supply as large as your requirements would call for.


Outfit No. 2.

We are pleased to call to your attention the services of our Engineering Department, which is available to help you in the solution of your problem, so do not fail to call on us for any information along this line.

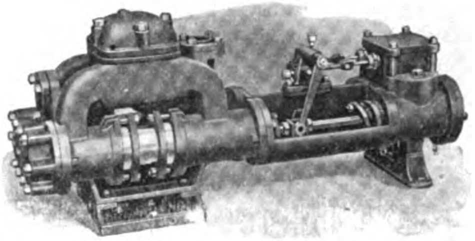

Outfit No. 33

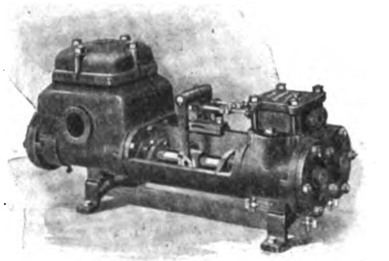

Outfit No. 38.

Ask for our book on pneumatic water systems for mines and factories.

Gardener Duplex Steam Pumps

You, as a prospective pump buyer, are first interested in the material and workmanship as expressed in the Gardener products. You determine in your own judgment for experience and capabilities of Gardener pumps to fulfill the things you, as a practical user, rightfully expect of them.

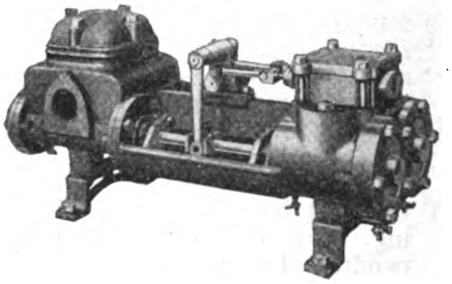




We are going to select the pumps to perform a certain service. Its value to you will, therefore, be measured by this standard.

Gardener Pumps are built to serve. Their quality displays itself through use—for use is the only real demonstration of quality.

Quality and **Gardener Products** is the **Union** of all good things blended—good material, good design, good workmanship, honest manufacture and satisfactory service.



We have in our Pittsburgh Stock for immediate shipment a number of these pumps at all times so that we can give you prompt service.

Ask for our catalog describing the Gardener line.

SEE PAGES 560 TO 567 AND 578, DEMING & MORRIS PUMPS IN STOCK AT PITTSBURGH FOR IMMEDIATE SHIPMENT

LUITWIELER PUMPING ENGINE CO.

Branch Office at
Cleveland, Ohio.

Main Office and Factory,
ROCHESTER, N. Y.

Los Angeles, Cal.
Pacific Coast Branch,

Designers and Builders of

The Luitwieler System of Pumps

(Non-Pulsating)

For Deep Pumping and Pressure Pumping

Products

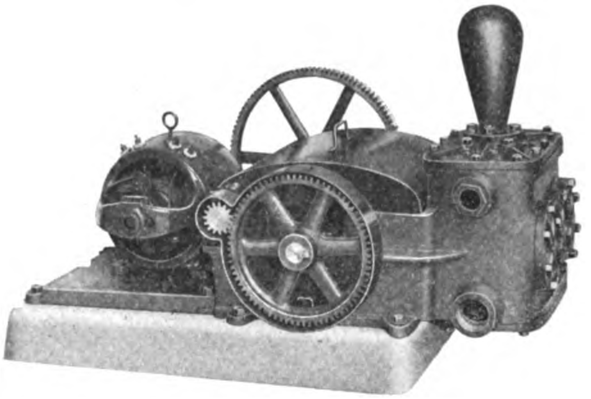
The Luitwieler System of Pumps (Non-Pulsating) for Deep Pumping and Pressure Pumping.

Our pumps are power pumps, and being non-pulsating in principle are steady in operation and particularly adapted for direct connected self-contained units.

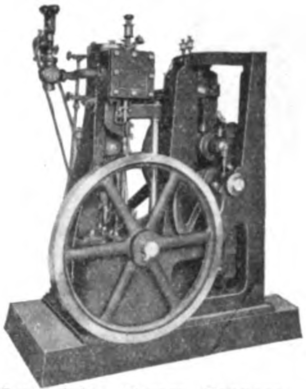
The steady load with the cam actuating principle makes a great saving in power, and gives durable and reliable service. We have had pumps on steady service for 20 years still doing good work.

Deep Well Pumping

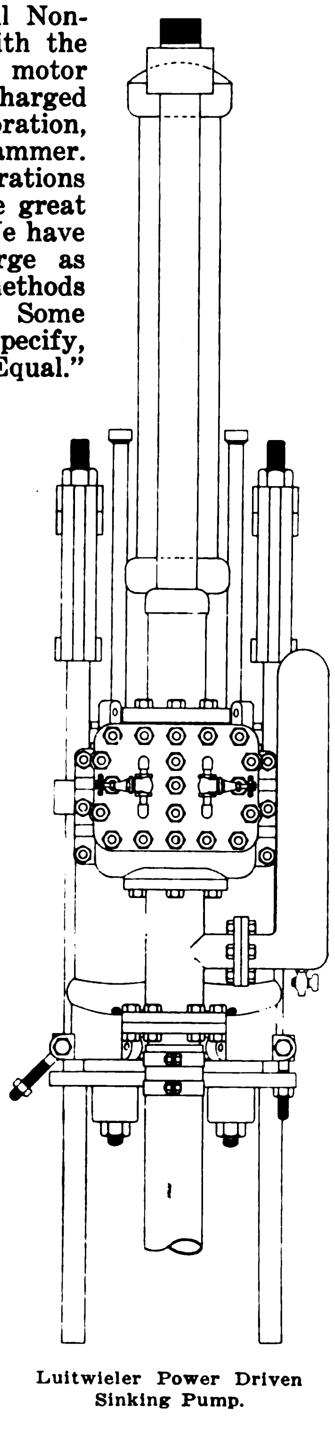
We build a line of Deep Well Non-Pulsating Cam Driven Pumps with the power steam, gasoline or electric motor on same base. The water is discharged in uniform flow without jar or vibration, back lash on gears, or water hammer. Mining companies and corporations using our Deep Well Pumps make great savings over any other system. We have records to show savings as large as 500% actually made over other methods which our pumps have displaced. Some designing water works engineers specify, "Luitwieler Deep Well Pumps or Equal."



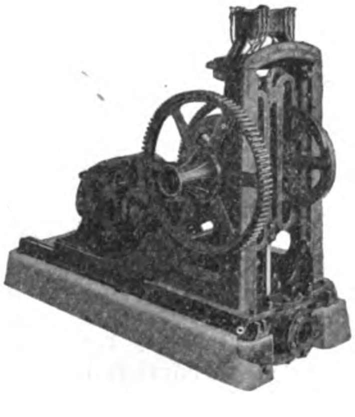
Luitwieler Direct Connected Non-Pulsating Type Triplex Pump, Double Acting.



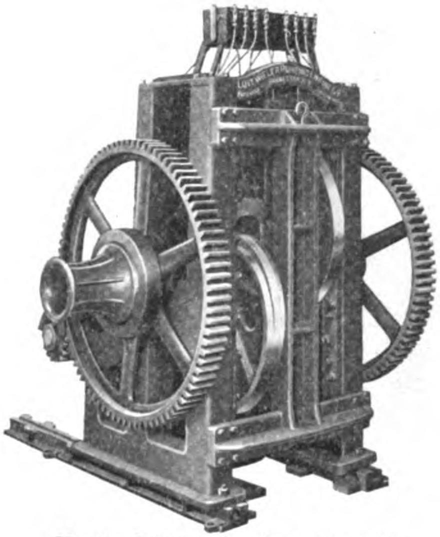
Luitwieler Direct Connected Steam Pumping Engine, Non-Pulsating



Luitwieler Power Driven Sinking Pump.



Luitwieler Direct Connected Electric Pumping Engine, Non-Pulsating.



Heavy Duty Belt Type Pumping Engine.

MORRIS MACHINE WORKS

BALDWINSVILLE, NEW YORK.

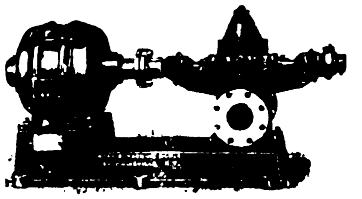
PITTSBURGH: Harris Pump & Supply Co
NEW YORK: Hungerford Bros. & Company.
CHICAGO: Henion & Hubbell.
CHARLOTTE, N. C.: Thos. B. Whitted.
BRANCH OFFICES IN PRINCIPAL CITIES.

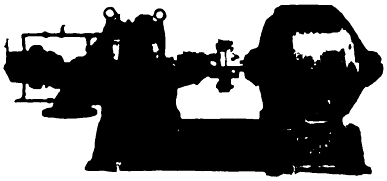
Products

Centrifugal Pumping Machinery, Hydraulic Dredges, Stationary and Marine Engines.

Horizontally Split Single and Multi Stage Pumps

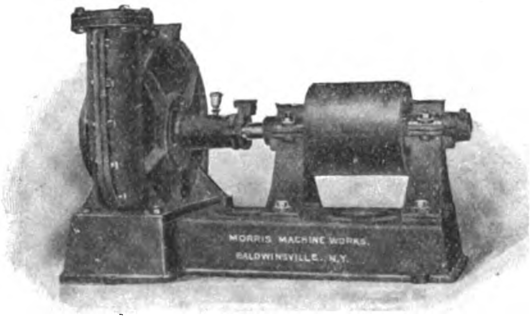
This type of Pump meets the demand for an efficient pump capable of operating at high speeds for direct connection to electric motor or steam turbine. Where the head is high it is built in stages. The suction and discharge opening are cast in the bottom half so that the pump can be taken apart without disturbing the pipe lines. The enclosed impellers are of bronze, accurately finished and balanced for high speeds. The shaft is of steel, protected by bronze sleeves through the stuffiing boxes. These pumps are equipped with outboard ring oiling bearings with removable babbited sleeves. The multi stage pumps have a water cooled marine type thrust bearing running in oil. The single stage pump is of the double suction type and whatever slight thrust develops is compensated by S. K. F. ball bearings. Leakage between stages is prevented by labyrinth impeller rings, which also maintain the efficiency of the pump.


4" Horizontally Split Single Stage Pump.


6"—2 Stage Hor. Split Multi Stage Pump.

Standard Horizontal Pumps

This pump is the type most extensively used for general work, and is especially adapted for Coal Mine duty on low lifts. There is a substantial babbitted bearing on each side of the pulley, which can be furnished of the ring oiling type if desired. The shaft is of large diameter, made of turned steel. The stuffing box is deep and arranged with gland. Sizes 1" to 12" inclusive are carried in stock.


Standard Horizontal Pump.

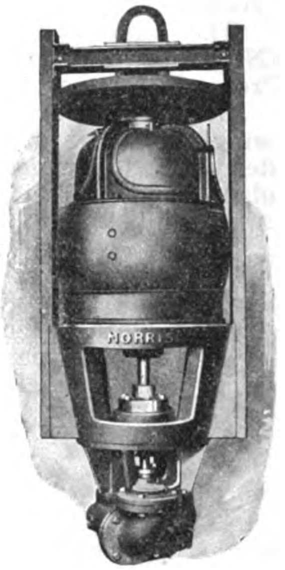
Sinking Pumps

Can be raised and lowered by cable.

Just another example of Morris outfits—one that is popular with mine managers for dewatering.

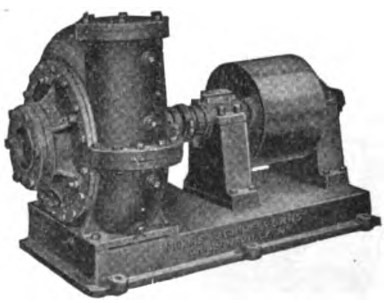
The illustration shows a 5 inch single stage pump with a capacity of 700 g. p. m. against 130 foot head.

It is assembled in a compact structural steel framework, directly connected to motor. The unit can be easily handled by a cable.



Solid Lined Dredging Pumps

This pump was originally designed for handling slimes in connection with gold recovery plants. The lining, which is practically an independent pump, is made either of Manganese Steel or Hard Cast Iron as desired. The impeller is of the enclosed type and of the same material as the liner. The bearings have removable babbited sleeves. For handling gritty water, coal, ashes, sand gravel, etc., this pump is unexcelled. It is built in sizes from two to twelve inches, some of which are carried in stock.


Solid Lined Dredging Pump.

There Are Over 50,000 Morris Pumps In Service.

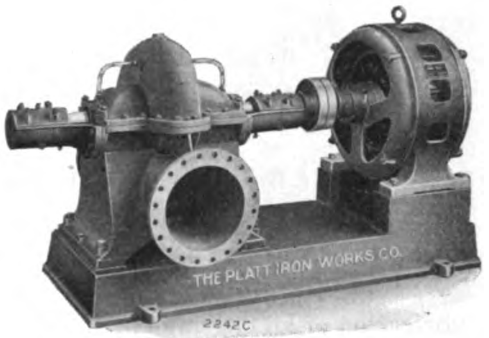
PLATT IRON WORKS

DAYTON, OHIO

Representatives in Principal Cities Insure Prompt and Efficient Service

Products

"Stilwell" Feed Water Heaters, Steam Pumps, Power Pumps, Centrifugal Pumps, Turbine Pumps, "Victor-Francis" Low Head Water Wheels, High Head Water Wheels, Tanks and Heavy Plate Work.



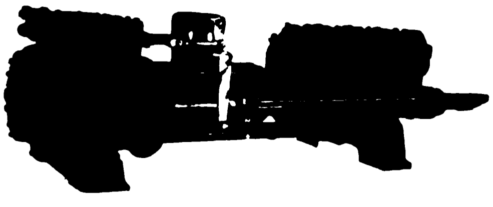
Platt Double Suction Centrifugal Pumps.

Specially designed for mining work, also municipal and industrial pumping installations, booster stations, irrigation and reclamation service.

Platt Double Suction Centrifugal Pumps are heavy, simple, durable, economical.

Made in sizes from 1½ to 50 inches for heads up to 1,000 feet.

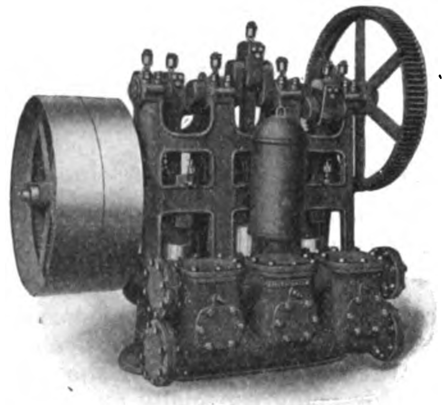
Bulletin 762 gives details.



Smith-Vaile Duplex Mine Pump, Pot Valve Style—Trombone Pattern.

Simple and compound patterns, for all pressures. A specially built and highly serviceable type for mine pumping purposes.

Bulletin 793 fully describes this and other types of Smith-Vaile pumping machinery.

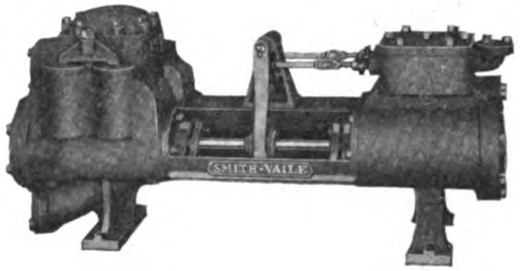


Smith-Vaile Triplex Pumps—Belt Drive, Chain Drive, Direct Geared.

For boiler feeding, water works, shallow and deep wells and general service. Construction features provide for a continuous and uniform movement of the fluid, insuring steady, even discharge.

Made in various types from 2½"x3" to 17"x15" with a maximum displacement of from 12.4 to 3,500 gallons per minute.

Full description of all types in Bulletin 781.



Smith-Vaile Duplex Pattern, Piston Packed Type, Yoke Style Pump.

For general service and boiler feeding. Designed for 150 pounds working pressure.

Made in sizes from 4x3x4 to 10x6x12.

Bulletin 793 describes this and other types of General Service Pumps.

STANDARD PUMPS FOR EVERY SERVICE

The Pneumelectric Machine Company

SYRACUSE, N. Y

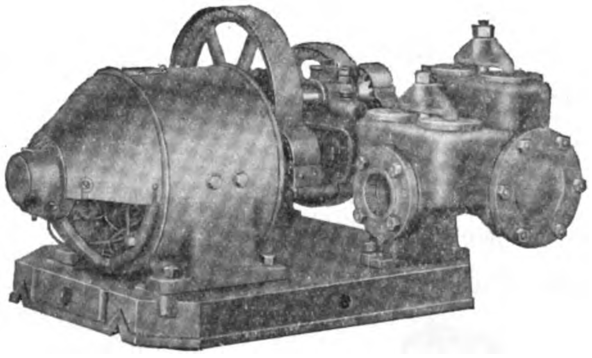
Pneumelectric
TRADE MARK

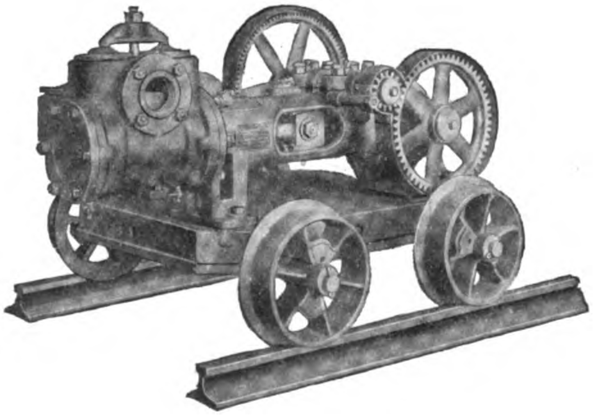
Electric Gathering Pump

Designed From the Experience of Many

The Pneumelectric Gathering Pump embodies the ideas of many practical mine men as to what a mine pump for gathering service should be.

It represents the use of materials based upon the most modern scientific investigations relating to the selection of the best materials for the service to be rendered. This being especially exemplified in the acid resisting metal that is used.





Special Features that Have Been Highly Developed

The design embodies extreme simplicity, accessibility, and construction that guarantees economical operation without interruption.

The lubrication of all bearings is made practically, automatic by means of felt wipers in oil reservoirs of ample capacity. This system assures positive lubrication at all times with the proper amount of oil, but at the same time, is most economical of the lubricant.

All bearings have replaceable bushings of highest quality bronze.

The cross head is of the high speed engine type with adjustable bronze shoes.

The crank shaft is one-piece with all bearing surfaces ground to dimensions.

Service tests of long duration and under extreme conditions have demonstrated the superiority of the acid resisting metal of which the water end is made.

Motor

The Pneumelectric Gathering Pump is designed to be driven by a self starting motor, and can be furnished with any of the standard makes of 3 or 5 H. P. motors of this type.

Water End

For highly acid water, the solid bronze water end and fittings are recommended. For less severe water conditions, either a cast iron or a cast iron bronze lined water end can be furnished.

Capacity

Sixty gallons per minute, against 150 foot head, the pump being 5"x6" double acting piston type.

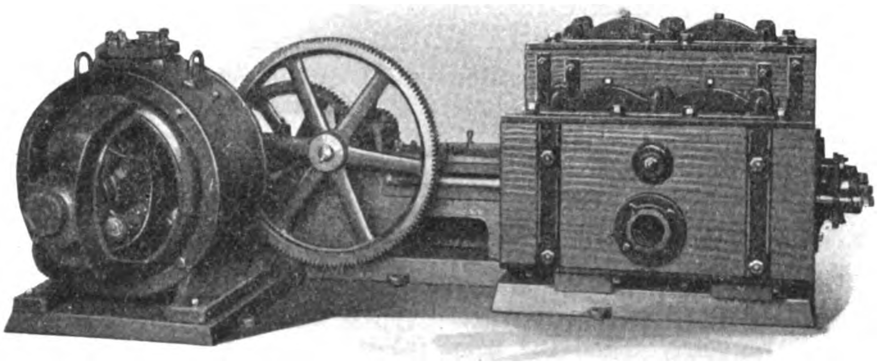
Dimensions

Height—25", Length—49", Width—45", Weight—850 Lbs. without motor; 1250 Lbs. with 3 H. P. motor.

THE STAR MANUFACTURING CO.

NEW LEXINGTON, OHIO, U. S. A.

"Murray" All-Wood Mine Pumps Will Work for Years In Any Acid Water



Used four years in sulphur water that eats pig iron up in 24 hours.

Zanesville, Ohio.

* * * *

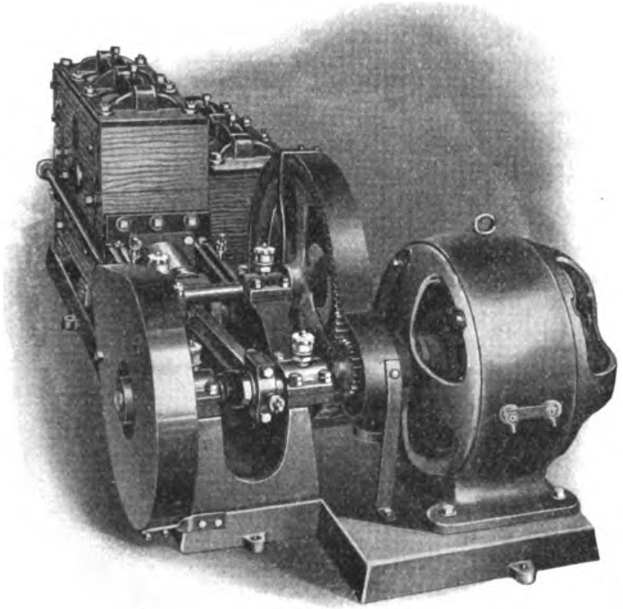
The upkeep is nothing compared to metal pumps. Used better than three years.

Wellston, Ohio.

* * * *

Repairs, replacements on Bronze pump more than the cost of Murray "All wood." No repairs on the Murray.

Tropic, Ohio.



Given continual service. No trouble. No expense. 2½ years.

Nelsonville, Ohio.

* * * *

Expended several hundred dollars in repairs on metal pumps. Only $3 on the Murray in one year.

Roseville, Ohio.

* * * *

Used in strong acid water, and has effected a great saving for us.

Athens, Ohio.

* * * *

Saved $200 in five months, by our figures, by using the Murray.

Nelsonville, Ohio.

* * * *

Used three years. Best machine investment that we have about our mine.

Columbus, Ohio.

* * * *

The Murray is pumping mine water in which we have never been able to keep another pump working for more than 2 and 3 days without stopping for repairs. We do not think that there is mine water stronger than ours. The Murray has run continuously for six months and more without repairs as yet.

Corning, Ohio.

* * * *

We have saved $150 a month with our Murray "All wood" pump.

Pitsburgh, Pa.

* * * *

We are content to rest our claims upon the actual service as experienced by Murray users.

We will mail the "Murray Catalog" to you upon request. Write for it today.

Reineke-Wagner Pump & Supply Co.

416 AND 418 FIRST AVENUE
PITTSBURGH, PA.

"Pump Specialists"

PUMPS FOR ALL PURPOSES, PIPE VALVES, FITTINGS AND GENERAL SUPPLIES

PITTSBURGH OFFICES AND WAREROOMS FOR

American Well Works	**Rumsey Pump Co.**
Leader Iron Works	**Union Steam Pump Co.**
Mast Foos & Co.	**Wagener Steam Pump Co.**

"Excelsiors" are powerful force pumps, durable and easily operated. Non-corrosive working parts adapt them to handling sea or mine water.

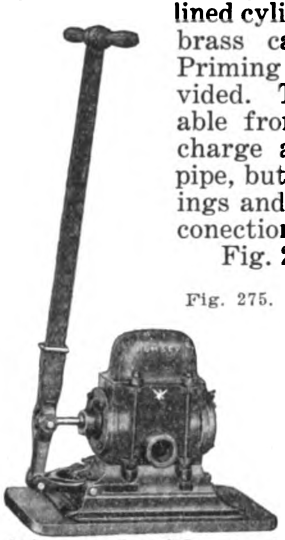


Fig. 275.

Their construction is simple and they are readily overhauled. They are regularly made with brass lined cylinder, bronze valves and seats, brass cased rod and brass gland. Priming plugs and drip plugs are provided. The lever is long and removable from socket. Suction and discharge are regularly fitted for iron pipe, but can be furnished with bushings and half hose couplings for hose conection to order at extra list.

Fig. 275 has single lever.

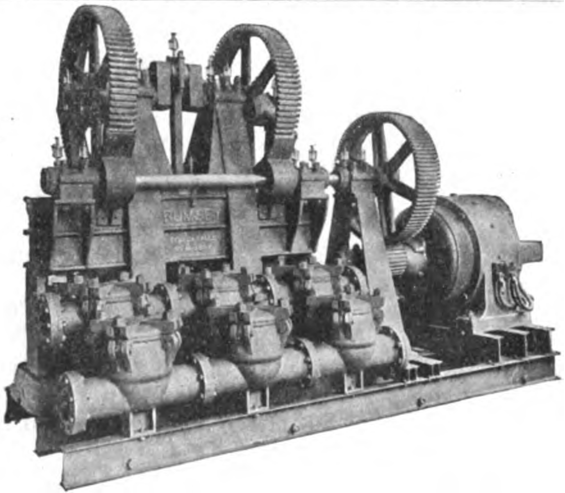
Fig. 274, not illustrated, is the same pump provided with two levers.

Rumsey Triplex Pumps

A complete line of triplex pumps, including several hundred standard styles and sizes of single and double acting pumps for belt, gear, chain or direct drive and with special fittings and equipment to meet any specifications. Capacities range up to 3,000 gallons per minute and pressure as high as 8,000 pounds. See table on opposite page which shows a partial list of single-acting pumps for moderate pressure.

EXCELSIOR PUMPS.

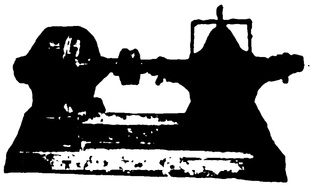
No.	Cylinder Diam. & Stroke Inches	Capacity Per Rev., Gallons	Pipe Sizes Inches.	Approx. Weight, Pounds	Brass Lined List	Brass Lined Cipher
			Fig. 275. Singe Lever Type.			
1	3x5	0.30	1¼	107	Bigotry	$28.00
2	4x5	0.54	2	117	Bijou	30.00
3	5x5½	0.93	2½	177	Bilbo	40.00
4	6x5½	1.34	2½	203	Bilge	50.00
			Fig. 274. Double Lever Type.			
1	5x5½	0.93	2½	217	Bimanous	45.00
2	6x5½	1.34	2½	232	Binary	55.00



Heavy Duty Stationary Mine Pump, Electric Triplex Type.

Centrifugal Pumps

Singe or multi-stage centrifugal pumps, either horizontal or vertical types, and for any service and capacity required.



Electric Centrifugal Pump

Steam Pumps

For boiler feeding or general service, built in many styles and sizes and suitable for any service for which a steam pump is required.

Gathering Pumps

A full range of pumps for gathering service. Electric units consisting of double acting power pumps or triplex pumps, as required, complete with sub-base, motor and gear drive.

Diaphragm Pumps

Bottom or side suction pumps for hand pumping or for drive by engine or motor. Suction hose complete with couplings and strainer can be furnished in any length desired.

Electric Gathering Pump

Valves, Hydrants and Supplies

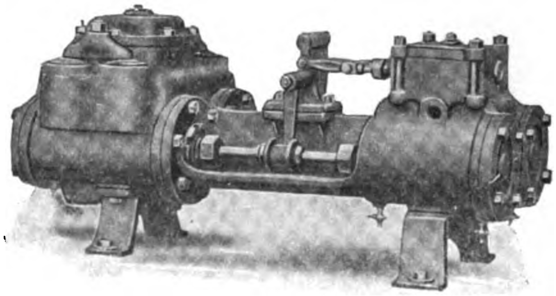
A large stock for prompt shipment.

Pipe and Pipe Fittings

In stock for propmt shipment.

Shipments From Stock

We carry a large assortment of hand and power pumps and supplies in order that we may render the best and promptest possible service to our customers.



Horizontal Steam Pump.

RUMSEY PUMP COMPANY, Ltd.

Boston SENECA FALLS, N. Y. New York

Reineke-Wagner Pump & Supply Co., Pittsburgh, Pa.
George H. Tay Company, San Francisco, Cal.
Fairbanks, Morse & Co., St. Louis, Mo.
Howard A. Young, Chicago, Ill.

Products.

Power Pumps for All Purposes, driven by belt, gear, chain or direct drive: including Triplex, Rotary and Centrifugal Power Pumps, Double-Acting Power Pumps, Deep Well Pumps and Waterworks Machinery. Hand Pumps of all kinds.

Catalogs.

General calatog of hand and power pumps, 56th edition, a complete reference book of pumping machinery; Catalog B, Triplex Power Pumps; Booklets and Bulletins.

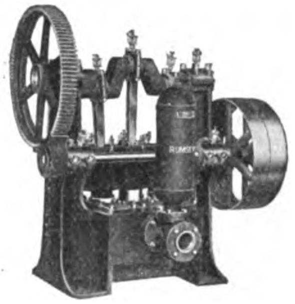


Fig. 681. Size5x6. Singe Geared Triplex Pump for Light Service.

Triplex Pumps.

The design is simple and compact, with all working parts accessible for inspection or adjustment. All parts are made from best materials. Only skilled workmen are employed for founding, machining and assembling. All pumps are rated at conservative speeds. The result is an article suitable for durable service.

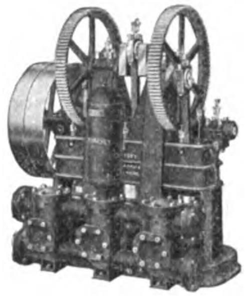


Fig. 698. Size 6x8. Double Geared Triplex Pump, Standard Type.

These pumps are offered in a wide range of styles and sizes for any pumping application: For general water supply and fire protection; municipal water works; boiler feeding, circulating, mine pumping; hydraulic elevators, exerting pressures; pumping special, liquids, chemicals, etc.

Construction details necessarily vary according to the service for which pumps are rated or special conditions under which they operate. Detailed specifications of any pump will be sent on request.

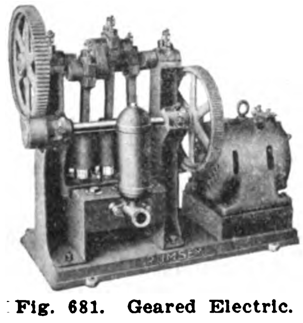


Fig. 681. Geared Electric.

Cranks are of the best cast or forged steel, of proper weight to take the heaviest strain to which thoy are subject. Bearings are of ample size, of bronze or lined with best babbit scraped to a true surface. Gearing is machine cut from solid. Water ways are large and direct. Valve areas are correctly proportioned. Glands are arranged to keep the plunger packing tight with a very slight pressure on the studs, preventing undue friction. All pumps are equipped with suitable oiling devices and drips.

Standard Sizes and Capacities, Moderate Pressure, Single Acting Triplex Plunger Pumps

Capacity per minute at moderate speed, gals.	Working pressurs, lbs.	Figure No.	Plunger diameter and stroke, ins.	Displacement per rev., gals.	Pipes		Standard pulleys, ins.	Cipher
					Suc., ins.	Dis., ins.		
1.5	150	681	1¼x2	0.03	1	¾	12x1½	Cabbage
1.5	200	684	1¼x2	0.03	1	¾	12x1½	Conclave
3.5	200	684	1½x3	0.07	1	1	12x2	Conclude
4.5	150	681	1¾x3	0.09	1	1	12x2	Cab
6	130	681	2 x3	0.12	1¼	1¼	12x2	Cabajal
8	200	684	2 x4	0.16	1¼	1¼	12x2½	Concoct
10	150	681	2¼x4	0.20	1¼	1¼	12x2½	Cabal
13	150	681	2½x4	0.25	1¼	1¼	12x2½	Cabaret
14	200	684	2½x4½	0.28	1½	1½	15x2½	Concord
20	150	681	3 x4½	0.41	1½	1½	15x2½	Cabin
25	150	681	3 5/16x4½	0.50	1½	1½	15x2½	Cablet
25	200	684	3 x5	0.46	1½	1½	20x3	Concur
30	150	681	3½x5	0.62	2	2	20x3	Cabob
35	200	684	3½x6	0.75	2	2	20x4	Concuss
50	150	681	4 x6	1.00	2½	2	20x4	Caboose
60	120	681	4½x6	1.24	3	2½	20x4	Caboosoon
75	150	681	5 x6	1.53	3	3	24x5	Cabotage
90	120	681	5½x6	1.85	3	3	24x5	Caburn
100	85	692	5 x8	2.00	3½	3	24x4	Coping
100	150	691	5 x8	2.00	3½	3	30x5	Communism
100	200	698	5 x8	2.00	3½	3	30x6	Coterie
125	65	692	5½x8	2.46	3½	3	24x4	Copse
125	125	691	5½x8	2.46	3½	3	30x5	Comet
125	165	698	5½x8	2.46	3½	3	30x6	Cotgare
150	55	692	6 x8	2.93	4	3½	24x4	Coquette
150	100	691	6 x8	2.93	4	3½	30x5	Commuter
150	140	698	6 x8	2.93	4	3½	30x6	Cotia
175	43	692	6½x8	3.44	4	4	24x4	Coquina
175	85	691	6½x8	3.44	4	4	30x5	Comose
175	120	698	6½x8	3.44	4	4	30x6	Cotoin
215	85	692	6½x10	4.30	5	4	30x6	Cordovan
215	150	691	6½x10	4.30	5	4	36x6	Compact
215	200	698	6½x10	4.30	5	4	42x6	Cotswold
250	195	690	7 x10	5.00	5	5	42x6	Comprint
270	75	692	7¼x10	5.35	6	5	30x6	Cormorant
270	125	691	7¼x10	5.35	6	5	36x6	Combing
270	160	698	7¼x10	5.35	6	5	42x6	Cotta
325	55	692	8 x10	6.50	6	5	30x6	Coronet
325	100	691	8 x10	6.50	6	5	36x6	Combative
325	130	698	8 x10	6.50	6	5	42x6	Cottage
345	150	690	8¼x10	6.94	6	5	42x6	Compart
415	125	690	9 x10	8.26	7	6	44x6	Compass
415	150	690	9 x10	8.26	7	6	42x10*	Compeer
445	185	690	9 x12	9.91	8	8	48x10*	Compile
510	100	690	10 x10	10.20	8	8	44x6	Complex
510	150	690	10 x10	10.20	8	8	42x10*	Compose
550	150	690	10 x12	12.24	8	8	48x10*	Compress
560	85	690	10½x10	11.25	8	8	44x6	Compotal
560	135	690	10½x10	11.25	8	8	42x10*	Compotete
570	215	788	10 x14	14.28	8	8	60x14†	Corrigent
605	135	690	10½x12	13.50	8	8	48x10*	Compret
690	90	789	11 x14	17.28	12	10	60x10*	Corposee
690	175	788	11 x14	17.28	12	10	60x14†	Corrifon
820	75	789	12 x14	20.56	12	10	60x10*	Corposant
820	150	788	12 x14	20.56	12	10	60x14†	Corral
965	65	789	13 x14	24.12	12	10.	60x10*	Corpulant
965	130	788	13 x14	24.12	12	10	60x14†	Correlate
1120	55	789	14 x14	27.98	12	10	60x10*	Corpuscle
1120	110	788	14 x14	27.98	12	10	60x14†	Corridor
1120	200	798	14 x16	32.00	12	10	72x20†	Corvette
1460	150	798	16 x16	41.77	14	12	72x20†	Corvine
1650	130	798	17 x16	47.16	14	12	72x20†	Corylus
1850	110	789	18 x16	52.85	14	12	72x20†	Corymb

*Single Pulley.
†Single Pulley for Double Belt.
Other Sizes have Tight and Loose Pulleys.

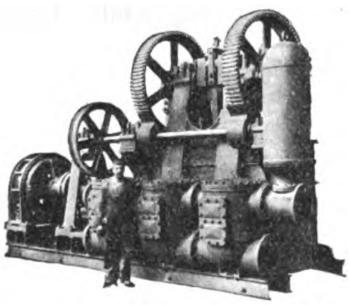


Fig. 798. Electric 2,000,000 Gallon Pumping Unit.

SWABY MANUFACTURING CO.

2010 MARSHALL BOULEVARD, CHICAGO, ILL.

SALES AGENCIES

PITTSBURGH, PA., 320-22 Second Avenue
DENVER, COLO., 1621-39 Seventeenth Street
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JOPLIN, MO., 209 E. Fourth Street

Centrifugal Pumping Machinery

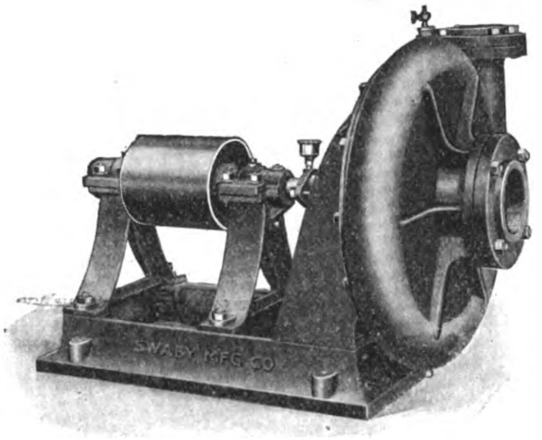


Fig. 1933 is a Horizontal Open Impeller Centrifugal Pump suitable for working pressures up to 50 feet. This pump is designed and constructed throughout on very liberal lines. The case or shell is of the solid type, very heavy, and the runner of large diameter, adapting the pump for slow speed.

The inside of the case is machine finished and the runner machined and accurately fitted to it; and our construction gives a closer running fit and greater efficiency than can be obtained in the old style split case.

The shaft is large and the bearings are generously proportioned, an ample stuffing box and gland being provided. All pumps No. 1½ and larger are provided with two self-oiling bearings. The discharge can be readily adjusted at any angle. All parts are accurately interchangeable and any part can be readily duplicated.

Fig. 1933. Horizontal Side Suction Centrifugal Pump—Sizes, Capacities, Etc.

No. Pump	Cap. Gals.	Size of Pipe		Pulley		Overall Dimensions			Weight Lbs.	H. P. per Ft. Elev.	Revolutions Per Minute									
		Disch. Ins.	Suct. Ins.	Diam. Ins.	Face Ins.	Length Ins.	Width Ins.	Height			5 Ft.	10 Ft.	15 Ft.	20 Ft.	25 Ft.	30 Ft.	35 Ft.	40 Ft.	45 Ft.	50 Ft.
2	100	2	2	5	5	21	15	14	110	.075	853	965	1063	1153	1237	1315	1389	1461	1530	1591
2½	150	2½	2½	6	5	25	19	19	175	.112	732	797	858	912	962	1014	1061	1107	1152	1194
3	225	3	3	7	6	31	24	23	300	.16	421	475	523	568	609	647	683	718	752	782
4	400	4	4	7	8	34	26	24	385	.25	373	430	480	525	566	605	642	677	710	740
5	700	5	5	10	8	38	29	27	525	.40	418	471	517	559	598	635	670	703	738	765
6	900	6	6	10	10	43	33	31	825	.50	358	408	452	493	531	565	597	629	659	687
8	1600	8	8	14	12	50	40	35	1225	.80	323	365	402	436	467	496	524	551	577	600
10	3000	10	10	20	12	55	43	40	1650	1.50	375	417	436	488	520	550	579	606	632	657

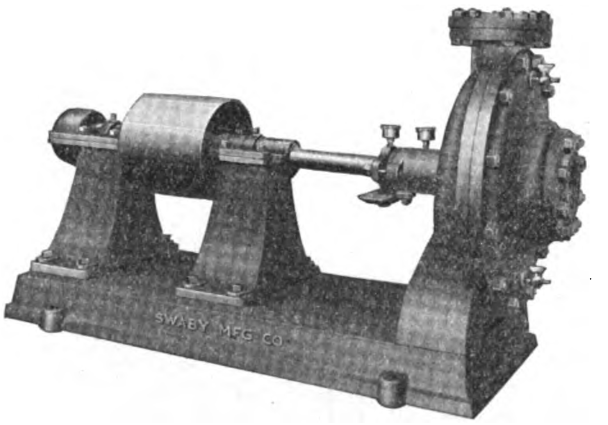


Fig. 1960 is a Horizontal Enclosed Impeller Centrifugal Pump suitable for working pressures up to 150 feet. When direct connected to elctric motor this is known as Fig. 1961 and can be adapted to motor speeds of 1800 R.P.M.

The runner is of the enclosed type, carefully machined and balanced and is designed to give the highest possible efficiency.

A removable front side gives ready access to the runner for inspection or repair. An ample stuffing box is provided, fitted with bronze separating ring, to which water is piped under pressure from the discharge volute, making a water seal and preventing air leakage into the suction through the stuffing box.

Two pedestal bearings of the self-oiling type support the shaft on both sides of the pulley. One of these bearings is provided with self-aligning ball bearings which keep the runner properly centered in the shell. Both bearings and shell are bolted to a heavy cast iron base, which forms an ample support, keeping all in perfect alignment.

Fig. 1960. Horizontal Enclosed Runner Centrifugal Pump—Sizes, Capacities, Etc.

No. Pump	Cap. Min.	Size of Pipe		Pulley		Overall Dimensions			Weight Lbs.		40 Ft.	50 Ft.	60 Ft.	70 Ft.	80 Ft.	90 Ft.	100 Ft.	110 Ft.	120 Ft.	130 Ft.	140 Ft.	150 Ft.
		Disch. Ins.	Suct. Ins.	Diam. Ins.	Face Ins.	Length Ins.	Width Ins.	Height Ins.														
3½	200 Gals.	3½	3½	7	6	48	23	29	770	Rev.	1310	1380	1450	1525	1590	1650	1710	1770	1820	1870	1930	1980
										H. P.	4.4	5.0	5.7	6.4	7.3	8.2	9.1	10.0	11.0	11.9	12.8	13.8
4	400 Gals.	4	4	7	6	48	24	29	830	Rev.	1200	1275	1350	1425	1500	1565	1625	1685	1740	1800	1860	1915
										H. P.	7.2	8.9	10.0	11.6	13.3	15.0	16.6	18.4	20.0	21.6	23.4	25.0
5	750 Gals.	5	5	10	8	58	25	31	1000	Rev.	1230	1300	1365	1430	1495	1555	1615	1675	1730	1785	1840	1895
										H. P.	15.0	16.0	18.0	20.0	23.0	26.0	29.0	32.0	35.0	38.0	41.0	44.0
6	1000 Gals.	6	6	10	10	59	26	32	1075	Rev.	1270	1335	1400	1460	1520	1580	1640	1700	1760	1820	1880	1920
										H. P.	18.2	21.5	24.6	27.8	30.8	34.6	38.4	42.3	46.1	50.1	53.8	57.7
8	1500 Gals.	8	8	10	10	62	28	34	1300	Rev.	1400	1460	1515	1570	1625	1680	1735	1790	1840	1890	1940	1990
										H. P.	33.3	37.5	40.9	43.7	48.4	53.6	57.7	63.4	69.2	75.0	80.8	86.5

CATALOGS AND PRICES ON APPLICATION

The Poole Engineering & Machine Co.

Factory and Office
WOODBERRY, BALTIMORE, MD.
Manufacturers of

Gears and Power Transmission Machinery

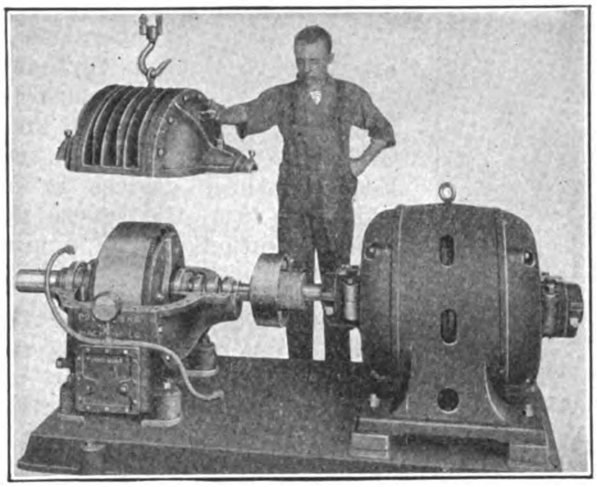
Since 1843

Products

The TURBO-GEAR, a patented, self-contained, mechanical power transmission interposed between and coupled directly to the prime mover and the driven unit, for the purpose of stepping up or stepping down speeds.

General Application

The Turbo-Gear can be used for all kinds of gear drives and its use permits the driving and driven units to run at their most efficient speeds with practically no loss in the speed transformation.



Standard Turbo-Gear direct connected to motor and showing horizontally split casing.

Motor Drive

The combination of a high-speed motor with a high-ratio Turbo-Gear gives a higher overall efficiency and lower power cost than can be obtained by any other form of transmission whether direct or indirect.

Turbine Drive

Steam turbines to be economical, must run at high speeds; many machines, such as centrifugal pumps, fans, generators, etc., which would lend themselves admirably to this type of prime mover, require much slower speeds than that of the turbine for their best efficiency. The Turbo-Gear correctly solves the problem by permitting each unit to run at its most efficient speed.

Engine Drive

In the case of steam, gas or oil engines, it is sometimes necessary to have higher speeds to secure the best efficiency for the driven unit. The Turbo-Gear is equally efficient in this case.

Gear Members

The Turbo-Gear consists of a large, internal, double-helical gear, made of a special-analysis, heat-treated steel forging, a double-helical pinion, cut integral with the high-speed shaft and made of heat-treated chrome-vanadium steel, and intermediate gears made of high-carbon steel forgings.

The intermediate gears are mounted on hardened and ground forged steel shafts with Hyatt Roller Bearings and secured to the cast-steel slow-speed member. On this slow-speed member, which is part of the slow-speed shaft, are mounted two heavy-duty S. K. F. ball bearings, one on each side of the gears, and supported directly by the substantial housing. Thus it will be seen that the slow-speed member and shaft carrying the intermediate gears, and the high-speed shaft and pinion are independent of one another for support and yet each is supported directly by the housing. The internal gear is stationary, the moving members are the pinion and the intermediate (planetary) gears.

Housing

The housing is made of tough, grey cast iron horizontally split, in accordance with the most approved practice, affording perfect accessibility to all parts. It is extremely substantial and well ribbed to afford a rigid support for the gear members, which is essential to efficient and quiet operation. The high and low speed bearings are provided with special sealing boxes, positively protecting them from the intrusion of grit and dust.

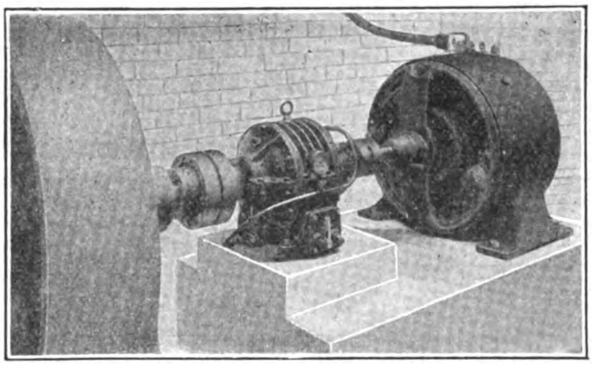
Lubrication

The high-speed shaft has a central passage through which the oil is pumped, and continuous streams of oil are sprayed on the gears through radial passages in the pinion.

The high-speed bearings beside having forced-feed lubrication are provided with oil rings and a good-sized reservoir for emergency use.

The superfluous oil from the high-speed bearing is collected by a centrifugal oil ring and forced through the hollow shafts carrying the intermediate gears, flushing their bearings.

The oil, after lubricating the bearings and gears, is immediately drained to the main oil reservoir in the base of the housing. Here it is filtered, cooled, and returned to the pump to be used over again.



Standard Turbo-Gear motor drive.

Guarantee

We guarantee every Turbo-Gear to be in perfect condition when leaving our factory, and will replace free of charge any part that may develope defects due to faulty design, material or workmanship, within one year from date of shipment, provided it has been installed and operated according to our instructions. **We further guarantee the Turbo-Gear to have an efficiency of not less than 97% at full load.** We will not assume any expense for repairs to any Turbo-Gear unless such repairs are made upon our written authority.

Service

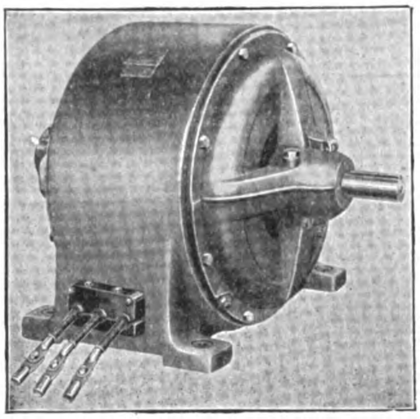
Our engineering department is at your service. Write for information and data sheet.

GENERAL ELECTRIC COMPANY

General Offices: Schenectady N. Y.
The Guarantee on Goods of Excellence Electrical
Sales Offices In All Large Cities

Electrical Equipment for Mines---Motors for Pumps

Dripping water, moisture saturated air and infrequent expert inspection are conditions under which mine pumps must operate. To prevent flooding, absolute reliability of operation is demanded of these pumps.



Centrifugal Pump Motor.

The General Electric Company has designed a special line of motors which are fully protected from these operating conditions.

Rigid box type frames enclosing moisture resisting windings give these motors the needed protection against water and humidity, and these windings are effectively cooled by self-ventilation.

Split end shields and bearings increase the accessibility of these motors for inspection while ample bearing surfaces and capacious oil wells make frequent examination unnecessary.

Absolute reliability of operation for these motors is assured by the above features as well as their ample overload capacities and reliable oiling devices.

Electric welds used in G-E squirrel cage pump motors between each rotar bar and its end rings give a joint capable of withstanding any overload temperature up to the melting point of the copper rotar bars.

Reliability of operation for the Form M Motor is further assured by drum type controllers and resistance of the well known G-E maximum service types. Each of these devices is fully protected from the severe operating conditions found in mines.

In order to reduce the size of these motors to make them suitable for installation in small places, without reducing their power capacities and to adapt them to centrifugal pump speeds high motor speeds are used.

Both high efficiencies and power factors have been maintained. Bulletin No. 61302, "Centrifugal Pump Motors," will be sent on request.

RATINGS OF HIGH SPEED,
INDUCTION MOTORS FOR DIRECT CONNECTION
TO CENTRIFUGAL PUMPS.—BOX FRAMES, 60 CYCLES.

Form K—Constant Speed.				Form M—Slip Ring Type.			
2240—440—550—2200 Volts.				220—440—550—2200 Volts.			
H. P.	Syn. Speed	Approx. Full Load Speed	Approx. Shipping Weight with Comp.	H. P.	Syn. Speed	Approx. Full Load Speed	Approx. Shipping Weight with Control
75	1800	1750	1790	75	1800	1740	2460
100	1800	1745	2350	100	1800	1740	2820
150	1800	1750	2840	150	1800	1750	3400
200	1800	1760	3660	200	1800	1760	4000
250	1800	1760	4900	250	1800	1760	5100
300	1800	1765	5900	300	1800	1770	6000
100	1200	1165	2700	100	1200	1175	3400
150	1200	1170	3660	150	1200	1175	3950
200	1200	1165	4700	200	1200	1170	4840
250	1200	1170	5600	250	1200	1175	5900
300	1200	1170	7300	300	1200	1175	7500
200	900	870	4650	200	900	875	5100
250	900	870	7200	250	900	875	7550
300	900	875	8200	300	900	875	8400

WESTINGHOUSE ELECTRIC & M'F'G CO.

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*W. E. & M. Co., of Texas.

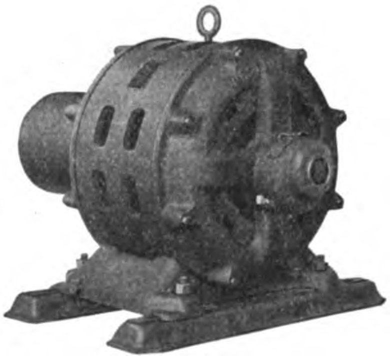
Co-Operative Service

Westinghouse Electric & Manufacturing Company, manufacturers of apparatus for both Generation, Application and Control of electric power, invite the Mine Operators to use the facilities of our engineering department in the planning and selecting of electrical equipment.

Type SK—Direct Current.

Westinghouse Type SK Direct Current Motors are designed for general constant and adjustable speed serivce and, therefore, find extensive application to machines used in or around mines, especially on machines where the load is frequently stopped and started.

The SK Motors are of steel construction, with few parts, all of which are readily accessible. The materials used have been selected so as to combine light weigth with great mechanical strength.



Type CS—Alternating Current.

Westinghouse Type CS Alternating Current Motors are designed for general constant speed service and are, therefore, applicable for driving machines in the mines. They are made in all standard sizes from 2 to 650 horsepower, for all commercial voltages and frequencies.

Forged open-hearth is largely used in the construction, which not only provides great strength but reduces the weight of the inactive material and overall dimensions to a minimum. The rotors are practically indestructible. The bearings have very liberal areas, are non-leaking and are protected from dirt and moisture.

The efficiency, power factor, and overload capacity are unusually high. Special attention has been given to this point, not only at full loads but at fractional loads, as a result of these features, Type CS Motors can be depended on to operate with maximum economy and to give satisfactory service for years with little attention.

Direct Current Type SK Motors

Shunt or Compound Wound. Open Type. Constant Speed

230 VOLTS.

H. P.	APPROXIMATE SPEED AT FULL LOAD.					
1½	900					
2	1200	850				
3 & 5	1800	1125	850			
7½	1700	1150	975	850	650	
10	1700	1300	1150	850	730	600
15	1700	1250	1100	825	675	600
20	1700	1100	900	750	650	
25	1400	1100	950	825	600	
30	1700	1150	975	725	600	
35	1700	1150	850	675		
40	1700	950	775	600		
50	1700	975	750	565		
60	1700	875	680			
65	575					
75	1700	1100	850	635	475	
85	540					
100	1700	1100	850	625		
120	720					
125	600					
150	1100	550				
200	850	500				
250	425					

550 VOLTS.

H. P.	APPROXIMATE SPEED AT FULL LOAD.					
2	1350	900				
3	1800	1200				
3½	900					
5	1800	1200	850			
7½	1750	1150	975	850	700	
10	1700	1300	1150	850	730	600
15	1700	1250	1100	825	675	600
20	1700	1100	900	750	650	
25	1400	1100	950	825	600	
30	1700	1150	975	725	600	
35	1700	1150	850	675		
40	1700	950	775	600		
50	1700	975	750	565		
60	1700	875	680			
75	1700	1100	850	635	475	
85	540					
100	1100	850				
120	720					
125	600					
150	1100	550				
200	500					
250	425					

CAST IRON PIPE MAKERS

The following makers of Cast Iron Pipe are Independent of of each other and competitors; inquiries may be sent to any or all of these with assurance of prompt and full response:

American Cast Iron Pipe Co.
Birmingham, Ala.

James B. Clow & Sons
Chicago, Ill.

Donaldson Iron Co.
Emaus, Lehigh Co., Pa.

Glamorgan Pipe & Foundry Co.
Lynchburg, Va.

Lynchburg Foundry Co.
Lynchburg, Va.

Massillon Iron & Steel Co.
Massillon, Ohio

U. S. Cast Iron Pipe & Fdry. Co.
Philadelphia, Pa.

Warren Foundry & Machine Co.
No. 11 Broadway, New York, N. Y.

Products

Cast Iron Bell and Spigot and Flanged Pipe and Fittings for Water and Gas; Flexible Joints for Submerged Lines; High Pressure Pipe and Specials for Fire Service; Plain End and Threaded Cast Iron Pipe; Cast Iron Culverts, Drains, Sewers, etc. Large and Small Special Castings.

Description

Cast Iron Pipe has for more than 250 years been the standard conduit for water and gas distribution underground, for which purpose it is better adapted than any other metal pipe.

Because of its crystalline structure, Cast Iron is proof against the destructive effects of corrosion evidenced by the scaling off of the laminated particles of the more highly refined and manipulated metals.

The life of Cast Iron Pipe has never been determined, and it is generally agreed that under normal conditions of soil and climate it will last forever.

Specifications

Following are the most important sections of the specifications of the American Water Works Association, which have been adopted by the above Makers as their manufacturing standard for water pipe:

STANDARD SPECIFICATIONS FOR CAST-IRON WATER PIPE AND SPECIAL CASTINGS, ADOPTED MAY 12, 1908.

Description of Pipe

Section 1—The pipe shall be made with hub and spigot joints and shall accurately conform to the dimensions given in Tables Nos. 1 and 2. They shall be straight and shall be true circles in section, with their inner and outer surfaces concentric, and shall be of the specified dimensions in outside diameter. They shall be at least 12 feet in length, exclusive of socket.

Allowable Variation in Diameter of Pipe and Sockets

Section 2—Especial care shall be taken to have the sockets of the required size. The sockets and spigots will be tested by circular gauges, and no pipe will be received which is defective in joint-room from any cause. The diameters of the sockets and the outside diameters of the spigot ends of the pipe shall not vary from the standard dimensions by more than .06 of an inch for pipe 16 inches or less in diameter; .08 of an inch for 18-inch, 20-inch and 24-inch pipe; .10 of an inch for 30-inch, 36-inch and 42-inch pipe; .12 of an inch for 48-inch, and .15 of an inch for 54-inch and 60-inch pipe.

Allowable Variation in Thickness

Section 3—For pipe whose standard thickness is less than 1 inch, the thickness of metal in the body of the pipe shall not be more than .08 of an inch less than the standard thickness, and for pipe whose standard thickness is 1 inch or more, the variation shall not exceed .10 of an inch, except that for spaces not exceeding 8 inches in length in any direction, variations from the standard thickness of .02 of an inch in excess of the allowance above given shall be permitted. For special castings of standard patterns a variation of 50 per cent. greater than allowed for straight pipe shall be permitted.

Defective Spigots May Be Cut

Section 4—Defective spigot ends on pipe 12 inches or more in diameter may be cut off in a lathe and a half round wrought-iron band shrunk into a groove cut in the end of the pipe. Not more than 12 per cent of the total number of accepted pipe of each size shall be cut and banded, and no pipe shall be banded which is less than 11 feet in length, exclusive of the socket.

Allowable Percentage of Variation in Weight

Section 7—No pipe shall be accepted the weight of which shall be less than the standard weight by more than 5 per cent for pipe 16 inches or less in diameter, and 4 per cent for pipe more than 16 inches in diameter, and no excess above the standard weight of more than the given percentage for the several sizes shall be paid for. The total weight to be paid for shall not exceed for each size and class of pipe received the sum of the standard weights of the same number of pieces of the given size and class by more than 2 per cent.

No special casting shall be accepted the weight of which shall be less than the standard weight by more than 10 per cent. for pipe 12 inches or less in diameter, and 8 per cent. for larger sizes, except that curves, Y-pieces and breeches pipe may be 12 per cent. below the standard weight, and no excess above the standard weight of more than the above percentages for the several sizes will be paid for. These variations apply only to castings made from the standard patterns.

Quality of Iron

Section 8—All pipe and special castings shall be made of cast iron of good quality, and of such character as shall make the metal of the castings strong, tough and of even grain, and soft enough to satisfactorily admit of drilling and cutting. The metal shall be made without any admixture of cinder iron or other inferior metal, and shall be remelted in a cupalo or air furnace.

The contractor shall have the right to make and break three bars from each heat or run of metal, and the test shall be based upon the average results of the three bars. Should the dimensions of the three bars differ from those given below, a proper allowance therefor shall be made in the results of the tests.

Tests of Material

Section 9—Specimen bars of the metal used, each being twenty-six inches long by two inches wide and one inch thick, shall be made without charge as often as the engineer may direct, and in default of definite instructions, the contractor shall make the test at least one bar from each heat or run of metal. The bars when placed flatwise upon supports twenty-four inches apart, and loaded in the center, shall support a load of 2,000 pounds, and show a deflection of not less than .30 of an inch before breaking; or if preferred, tensile bars shall be made which will show a breaking point of not less than 20,000 pounds per square inch.

Casting of Pipe

Section 10—The straight pipe shall be cast in dry sand molds in a vertical position. Pipe 16 inches or less in diameter shall be cast with the hub end up or down, as specified in the proposals. Pipe 18 inches or more in diameter shall be cast with the hub end down.

The pipe shall not be stripped or taken from the pit while showing color of heat, but shall be left in the flasks for a sufficient length of time to prevent unequal contraction by subsequent exposure.

Quality of Castings

Section 11—The pipe and special castings shall be smooth, free from scales, lumps, blisters, sand holes and defects of every nature which unfit them for the use for which they are intended. No plugging or filling will be allowed.

Cleaning and Inspection

Section 12—All pipe and special castings shall be thoroughly cleaned and subjected to a careful hammer inspection. No casting shall be coated unless entirely clean and free from rust, and approved in these respects by the engineer immediately before being dipped.

Coating

Section 13—Every pipe and special casting shall be coated inside and out with coal-tar pitch varnish. The varnish shall be made from coal tar. To this material sufficient oil shall be added to make a smooth coating, tough and tenacious when cold, and not brittle nor with any tendency to scale off.

Hydrostatic Test

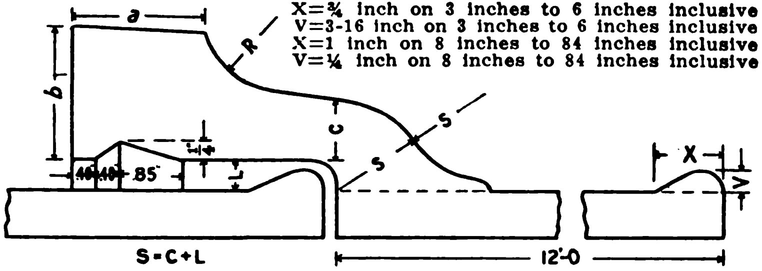
Section 14—When the coating has become hard, the straight pipe shall be subjected to a proof by hydrostatic pressure, and, if required by the engineer, they shall also be subjected to a hammer test under this pressure.

The pressure to which the different sizes and classes of pipe shall be subjected are as follows:

	20-Inch Diameter and Larger, Pounds per Square Inch.	Less than 20-Inch Diameter, Pounds per Square Inch.
Class A Pipe.	150	300
Class B Pipe.	200	300
Class C Pipe.	250	300
Class D Pipe.	300	300

Castings to Be Delivered Sound and Perfect

Section 19—All the pipe and other castings must be delivered in all respects sound and conformable to these specifications. The inspection shall not relieve the contractor of any of his obligations in this respect, and any defective pipe or other castings which may have passed the engineer at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the contractor shall not be held liable for pipe or special castings found to be cracked after they have been accepted at the agreed point of delivery. Care shall be taken in handling the pipe not to injure the coating, and no pipe or other material of any kind shall be placed in the pipe during transportation or at any time after they have received the coating.



X=¾ inch on 3 inches to 6 inches inclusive
V=3-16 inch on 3 inches to 6 inches inclusive
X=1 inch on 8 inches to 84 inches inclusive
V=¼ inch on 8 inches to 84 inches inclusive

Nominal Diam., Inches	Classes	Actual Outside Diam., Inches	Diam. of Sockets: Pipe, Inches	Diam. of Sockets: Special Castings, Inches	Depth of Sockets: Pipe, Inches	Depth of Sockets: Special Castings, Inches	A	B	C
4	A	4.80	5.60	5.70	3 50	4.00	1.5	1.30	.65
4	B–C–D	5.00	5.80	5.70	3.50	4.00	1.5	1.30	.65
6	A	6.90	7.70	7.80	3.50	4.00	1.5	1.40	.70
6	B–C–D	7.10	7.90	7.80	3.50	4.00	1.5	1.40	.70
8	A–B	9.05	9.85	10.00	4.00	4 00	1.5	1.50	.75
8	C–D	9.30	10.10	10.00	4.00	4.00	1.5	1.50	.75
10	A–B	11.10	11.90	12.10	4.00	4.00	1.5	1.50	.75
10	C–D	11.40	12.20	12.10	4.00	4.00	1.5	1.60	.80
12	A–B	13.20	14.00	14.20	4.00	4.00	1.5	1.60	.80
12	C–D	13.50	14.30	14.20	4.00	4.00	1.5	1.70	.85
14	A–B	15.30	16.10	16.10	4.00	4.00	1.5	1.70	.85
14	C–D	15.65	16.45	16.45	4.00	4.00	1.5	1.80	.90
16	A–B	17.40	18.40	18.40	4.00	4.00	1.75	1.80	.90
16	C–D	17.80	18.80	18.80	4.00	4.00	1.75	1.90	1.00
18	A–B	19 50	20.50	20.50	4.00	4.00	1.75	1.90	.95
18	C–D	19.92	20.92	20.92	4.00	4.00	1.75	2.10	1.05
20	A–B	21.60	22.60	22.60	4.00	4.00	1.75	2.00	1.00
20	C–D	22.06	23.06	23.06	4.00	4.00	1.75	2.30	1.15
24	A–B	25.80	26.80	26.80	4.00	4.00	2.00	2.10	1.05
24	C–D	26.32	27.32	27.32	4.00	4.00	2.00	2.50	1.25
30	A	31.74	32.74	32.74	4.50	4.50	2.00	2.30	1.15
30	B	32.00	33.00	33.00	4.50	4.50	2.00	2 30	1.15
30	C	32.40	33.40	33.40	4.50	4.50	2.00	2.60	1.32
30	D	32.74	33.74	33.74	4.50	4.50	2.00	3.00	1.50
36	A	37.96	38.96	38.96	4.50	4.50	2.00	2.50	1.25
36	B	38.30	39.30	39.30	4.50	4.50	2.00	2.80	1.40
36	C	38.70	39.70	39.70	4.50	4.50	2.00	3.10	1.60
36	D	39.16	40.16	40.16	4.50	4.50	2.00	3.40	1.80
42	A	44.20	45.20	45.20	5.00	5.00	2.00	2.80	1.40
42	B	44.50	45.50	45.50	5.00	5.00	2.00	3.00	1.50
42	C	45.10	46.10	46.10	5.00	5.00	2.00	3.40	1.75
42	D	45.58	46.58	46.58	5.00	5.00	2.00	3.80	1.95
48	A	50.50	51.50	51.50	5.00	5.00	2.00	3.00	1.50
48	B	50.80	51.80	51.80	5.00	5.00	2.00	3.30	1.65
48	C	51.40	52.40	52.40	5.00	5.00	2.00	3.80	1.95
48	D	51.98	52.98	52.98	5.00	5.00	2.00	4.20	2.20

STANDARD THICKNESS AND WEIGHTS OF CAST-IRON PIPE

Table No. 2 Classes A, B, C, D

Nominal Inside Diameter, Inches	Class A 100-Feet Head 43 Pounds Pressure: Thickness, Inches	Class A: Weight per Foot	Class A: Weight per Length	Class B 200-Feet Head 86 Pounds Pressure: Thickness, Inches	Class B: Weight per Foot	Class B: Weight per Length	Class C 300-Feet Head 130 Pounds Pressure: Thickness, Inches	Class C: Weight per Foot	Class C: Weight per Length	Class D 400-Feet Head 173 Pounds Pressure: Thickness, Inches	Class D: Weight per Foot	Class D: Weight per Length	Nominal Inside Diameter, Inches
4	.42	20.0	240	.45	21 7	260	.48	23.3	280	.52	25.0	300	4
6	.44	30 8	370	.48	33 3	400	.51	35 8	430	.55	38.3	460	6
8	.46	42.9	515	.51	47 5	570	.56	52.1	625	.60	55.8	670	8
10	.50	57.1	685	.57	63 8	765	.62	70.8	850	.68	76.7	920	10
12	.54	72.5	870	.62	82.1	985	.68	91.7	1100	.75	100.0	1200	12
14	.57	89.6	1075	.66	102.5	1230	.74	116.7	1400	.82	129.2	1550	14
16	.60	108.3	1300	.70	125.0	1500	.80	143.8	1725	.89	158.3	1900	16
18	.64	129.2	1550	.75	150 0	1800	.87	175.0	2100	.96	191.7	2300	18
20	.67	150.0	1800	.80	175.0	2100	92	208.3	2500	1.03	229.2	2750	20
24	.76	204.2	2450	.89	233 3	2800	1.04	279.2	3350	1.16	306.7	3680	24
30	.88	291.7	3500	1.03	333.3	4000	1.20	400.0	4800	1.37	450.0	5400	30
36	.99	391.7	4700	1.15	454.2	5450	1.36	545.8	6550	1.58	625.0	7500	36
42	1.10	512.5	6150	1 28	591.7	7100	1.54	716.7	8600	1.78	825.0	9900	42
48	1 26	666.7	8000	1.42	750 0	9000	1.71	908.3	10900	1.96	1050.0	12600	48

The above weights are per length to lay 12 feet, including standard sockets; proportionate allowance to be made for any variation.

A. M. BYERS COMPANY

PITTSBURGH, PA.

Genuine Wrought Iron Pipe, Couplings and Nipples

Black and Galvanixed. Sizes, 1-8 in. to 12 in. Standard, Extra Heavy, Double Extra Heavy.

General

Owing to its cheapess and ease of manufacture, steel many years ago replaced wrought iron for the manufacture of wire, nails, sheets, rails and structural shapes. Such, however is not the case with pipe, for the tonnage of Byers wrought iron pipe manufactured continues to advance as its value for water, steam, and gas lines becomes more and more recognized.

The reasons for the strong hold of genuine wrought iron pipe is that it possesses four cardinal features which differentiate it from steel pipe. While these features are common to all hand-puddled wrought iron, it should be borne in mind that there are different qualities of wrought iron, all of which do not possess these features to the same degree; also the word BYERS has been associated with the term genuine hand-puddled wrough iron for so long that today they are synonymous.

The four features are as follows:

1. **Better Welding**—The efficiency of a weld is measured by the effectiveness of the union of metal to metal. When welding steel, the blacksmith uses borax as a flux to assist adhesion, but such fluxing is obviously impracticable in making pipe. On the other hand, the welding of wrought iron requires no addition of flux, the slag content making it self-fluxing. This explains why the weld in wrought iron pipe is more efficient that that in steel. Crushing tests show that in 94 cases out of a hundred, the weld in Byers pipe is as strong or stronger than the body-metal.

2. **Threading**—The superior threading qualities of Byers pipe are due to the characteristic wrought iron fibrous structure which causes the chips to break or crumble, thus reducing friction and preventing the chip space from clogging. The result is a clean, minutely accurate thread which will make a permanently strong, leak-proof joint. The inherent advantages of the metal, aided by the high standard of threading maintained in the Byers mills, makes for the utmost in strength, toughness, tightness and alignment of pipe joints.

3. **Resistance to Shocks and Vibration**—The fibrous nature of the iron enables Byers pipe to withstand shocks and vibration much better than steel does, in spite of the slightly higher tensile strength of the latter. Figures for tensile strength, elastic limit and elongation are valueless as a criterion of endurance under vibratory stresses and repeated shocks.

Steel resembles glass in its characteristics and any minute fracture soon develops when subjected to vibration, expansion, shocks and stresses until failure occurs. On the other hand, the slag in wrought iron arrests the progress of minute fissures before they can develop to appreciable size. Steel may further be likened in structure to a solid bar of metal, while wrought iron resembles stranded wire cable.

The ability of wrought iron to withstand severe shocks without fracturing is nowhere of greater importance than in mine service where falls of the roof are likely to occur, and in pumping and power plant service generally where there is more or less vibration. Experience has shown that wrought iron bends under repeated stresses while steel shatters.

4. **Resistance to Corrosion**—Iron when taken out of the puddling furnace consists of a spongy mass of plastic iron globules thinly coated with slag or cinder. During the rolling process the globules become elongated and the slag takes the form of fine bands lying between the long iron fibres. This slag is composed of non-corrosive silicates.

It is due to the presence of more than 250,000 of these slag bands in every inch of metal that Byers pipe shows such great resistance to corrosion. When corrosive agencies begin to act, more and more of the slag becomes exposed, protecting the underlying metal and considerably minimizing the effect of pitting. There is no protective slag present in steel and, consequently, when corrosion starts there is nothing to retard its progress and the result is a deep pit which, in a comparatively short time, tends to penetrate the wall of the pipe.

Specific cases showing the life of wrought iron and steel pipe in service in and around mines will be furnished upon request.

Identification—Excepting only the smallest sizes, including ⅛″ standard and ⅛″ and ¼″ extra heavy, all Byers pipe has the Name and Year of Manufacture rolled in the iron every three or four feet as shown in the illustration.

Ask for Bulletin No. 26 containing complete information and tables; also Bulletin No. 27, "The Experience of Practical Men."

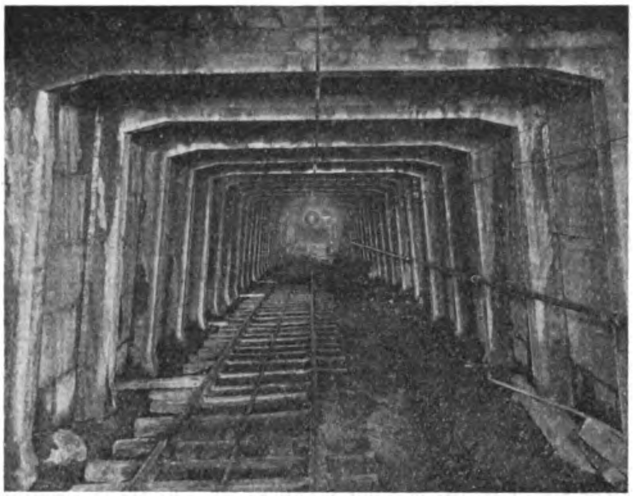
Concrete Products Co. Of Pittsburgh

Diamond Bank Building, PITTSBURGH, PA.

Manufacturers of

Reinforced Concrete

Mine Timbers, Crib Wall Members, Culvert and Drain Pipe



Slope Mine Lining.
American Zinc & Chemical Co., Burgettstown, Pa.

DESCRIPTION

Mine Timbers

Posts, beams and lagging in standard sizes for slope and shaft lining. Effectively reinforced for steady and impact loads. Mortised joints require only a setting in cement mortar for erection. Can be handled readily. Fireproof and permanent.

Crib Wall Members

Stretchers and headers, thoroughly reinforced. Designed for open and solid walls up to 12 ft. in height with surcharge. Assembled like timber cribbing and held together with steel dowels. Used for retaining walls on railroads, wing walls for side-hill mine portals, etc. Cheaper and more conveniently erected than concrete in place.

Culvert and Drain Pipe

Made in standard and extra-heavy grades, and all sizes up to 96″ diameter. Used for sewers, railroad and highway culverts, water mains, mine entries, general mine drainage and drainage of spoil banks in stripping operations. Thoroughly reinforced. Not affected by sulphur water.

Materials

All concrete a 1:2:4 mix of Portland cement, and Ohio River sand and gravel. Properly graded and proportioned to give maximum density and strength.

All products are factory made, under careful supervision, by the most approved methods, and carefully cured before being shipped. Dense, strong, impermeable concrete is obtained by compacting in the forms on a jarring machine. The aggregate is screened and graded and the mix proportioned to give the greatest possible strength and density. It is of a high acid resisting character and is eminently satisfactory for use when in contact with sulphur water. The reinforcing is continuous, using a high elastic limit steel. Forms are rigid, water tight, and true to plan. Can be erected as readily as any other structural material, and is absolutely safe, fireproof and permanent.

60″ Pipe Under Fifty Foot Spoil Bank.

THE MICHIGAN PIPE COMPANY

BAY CITY, MICHIGAN

Products

"Michigan" Wood Mine and Acid Pipe.

"Michigan" Hard Maple, Beech and Birch Pipe (for flushing clum).

"Michigan" Tin-Lined Wood Casings for insulating underground or overhead heating pipes.

"Michigan Wood Mine and Acid Pipe

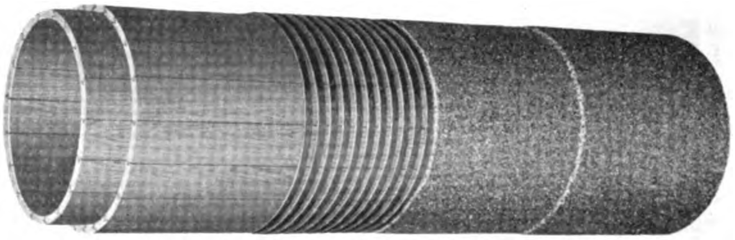
is manufactured from selected Michigan White Pine and Tamarack Timber, thoroughly inspected and seasoned, spirally bound under heavy tension with galvanized steel wire or hoop iron, coated with imperishable asphaltum cement. This pipe is extensively used by coal mining operations and collieries throughout the United States, and will resist the action of sulphurous or acidulous liquids in the soil or conveyed through the pipe line.

"Michigan" Wood Mine Pipe is naturally acid-proof, it is light, strong, burst-proof, and inexpensive in first cost. "Michigan" Wood Pipe is the logical wood pipe for mine use, and for use wherever economy is an important factor of consideration, and where life-long satisfactory service is desired.

The advantages over metal pipes are many: Metal pipe is the natural victim of acids, it is high in first cost, liable to burst, and has other objectionable features. Before you give this matter of piping serious though, it is for your interest to investigate "Michigan" Pipe.

"Michigan" Hard Maple, Beech and Birch Pipe

(For flushing culm), is manufactured in a similar manner to our water pipe from especially selected, seasoned hard maple, beech and birch timber, constructed with an extra thick shell and tenon. Used in the anthracite coal districts for conveying culm or fine coal dust and slate from the washeries.



"Michigan" Combination Steel and Water Pipe.

"Michigan" Hard Maple and Beech Pipe is unaffected by sulphur water and simply wears smooth by the friction of the flowing culm, where iron pipe in a short time is eaten and scratched through, rendering it useless. The life of this pipe is estimated ten times the life of metal pipe.

"Michigan" Tin-Lined Wood Casings

for insulating underground or overhead steam, or hot water heating pipes. "Michigan" Casings are made of well seasoned pine and tamarack wood, with a shell or wall of 4, 3 and 2 inches in thickness; of the solid log in the smaller sizes, and in the built up form (stave with tongue and groove) in the larger sizes, in lengths of 6 to 8 ft., strengthened with a No. 6 double galvanized steel wire. The interior of casing has a lining of bright tin, and the outer surface is covered with heavy waterproof asphaltum, and rolled when hot in sawdust. An average dead air space of 2 to 3½" is allowed between the wrought-iron pipe and the covering. The mortise and tenon points fit snuggly together and are simply driven together.

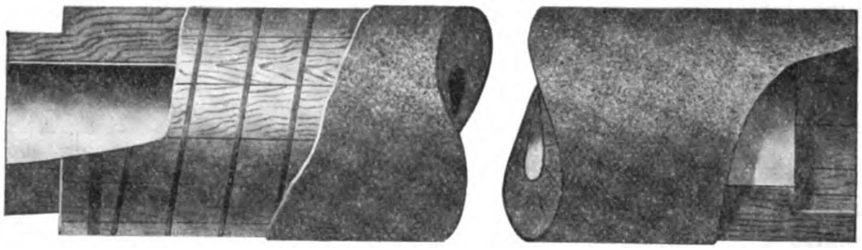
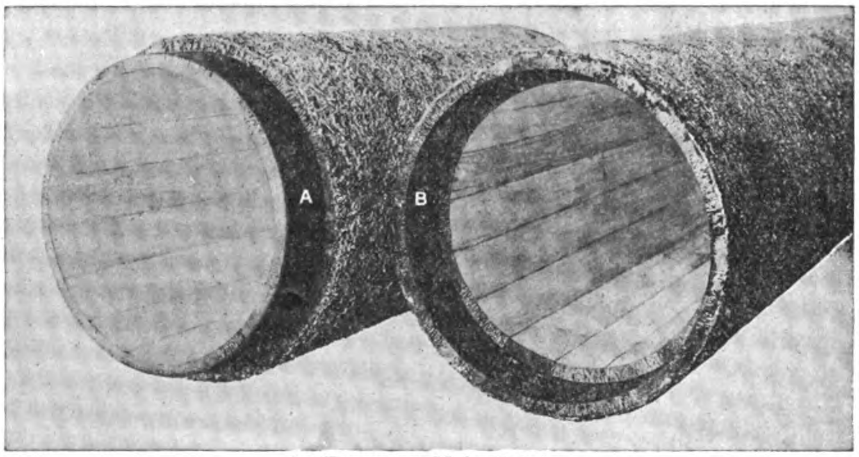


Fig. 2 "Michigan" Tin-Lined Wood Casings for Insulating Underground or Overhead Steam Pipes.



A—Tenon or Male Joint.
B—Mortise or Female Joint.

STANDARD WOOD PIPE COMPANY

WILLIAMSPORT, PA

Manufacturers of

Wood Water Pipe, and Steam Pipe Casing

Product

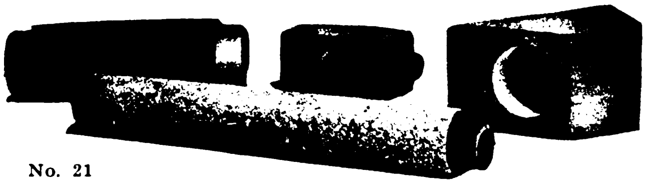
Manufacturers of wood water pipe for Coal Mines and Chemical Works to carry mine water, culm, fluids, acids, pulp and brine. For Water Works system, Power Plants. and Railroad Water Supply. Steam pipe covering for insulating underground steam pipes.

No. 18

The above cut illustrates two sections of pipe, on the left it is complete with coating, and on the right is the banding before it is coated. The pipe is made of white pine, douglas fir or cypress. Maple lumber we use for slushing culm. We wind with either hoops or galvanized wire, full consideration is given to the effects of the various compression, swelling and tensile strain.

We manufacture the pipe of staves and of solid bore. The staves are machined with a double tongue and grooved with faces plain. Staves are made of the thickness according to the sizes of pipe from lumber 1½", 2", 2½" and 3".

All our pipe is made under the supervision and approval of the most experienced and competent engineers, who readily recognizes its fitness, practical and economical value. The spacing of the bands or the double galvanized wire is according to the pressure required. The pipe receives a double coating of the best grade of hydrolene or asphaltum. The pipe is built from 1½" to 48" in diameter.

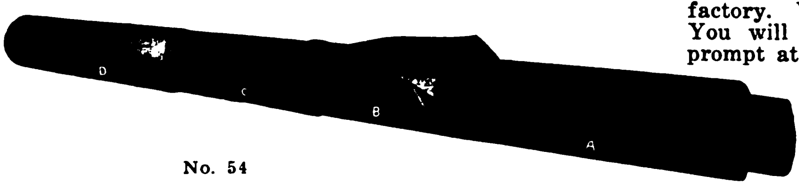


No. 21

The above illustrates wooden specials. We make connections of wood of any angle to withstand various pressures and various sizes to fit the wood pipe, especially for coal mines and chemical plants where iron fittings cannot be used. We also make cast iron connections of all designs.

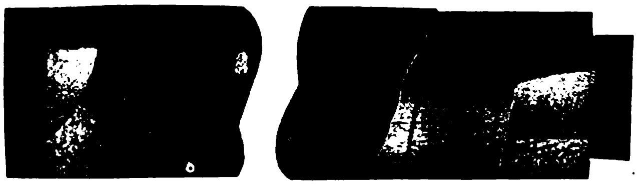
In the above illustration A shows a complete section of wood pipe. B shows a section of pipe with tenon on each end, used in some instances to connect fittings where the bell of the fitting faces the bell of the pipe. C shows a wooden tee, and D shows a 45° wood elbow.

The cut below illustrates our rubberized water pipe. See letter A body of wood pipe, B rubberized lining, C steel bands, and B asphaltum covering. The object of having a non-corrosive rubberized lining between the wood pipe and the steel bands is in order, to protect the bands from the acid water, which might seep through the wood, especially when the line is working under pump force or suction. For further information write for our folder No. 3, which illustrates in detail the merits of this wood pipe.



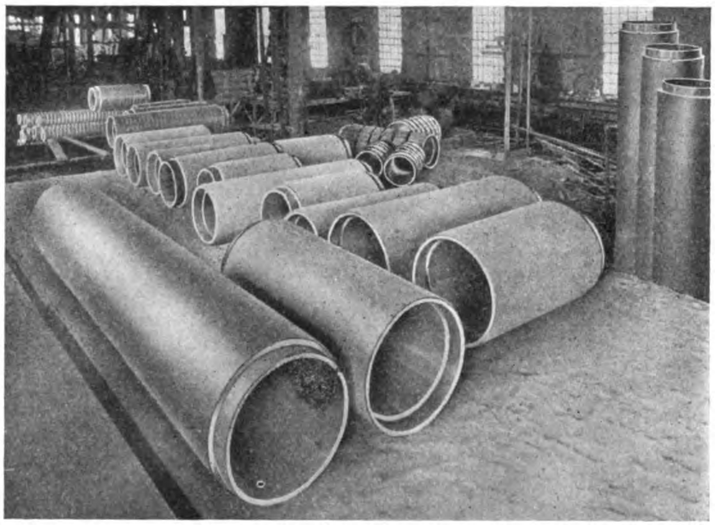
No. 54

Cut below gives a full view of the construction of our steam pipe casing. The lumber used by us for manufacturing our steam casing is selected live white pine thoroughly air dried before it is milled into staves. The length of the casing is made from 6' up to 12'. The thickness of the staves is made 2", 3" and 4", heavier if desired. Staves are assembled in a cylindrical form, with tongues and grooves extending the entire length. They are banded with No. 6 galvanized wire from end to end under heavy tension sufficient to imbed the wire into the wood. Each section is provided with a tenon and chamber smoothly machines to fit, so they are easily driven together. The tenon and chamber are treated with a compound of creosote. The outside of the casing is thoroughly coated with a hot preservative, which is a thorough protection to the wood and wire, after which it is rolled in sawdust to facilitate handling. The tin lining consists of the best grade AAAA charcoal tin plate. The wire is held firmly by staples staggered every 9".



No. 44

For full particulars write for our booklet No. 2.



No. 57

The above view shows part of the interior work of our factory. We have the latest type of improved machinery. You will find our material of the highest grade, with prompt attention and satisfactory prices. Our best attention is given to inquiries for prices and for general information. We have the most practical man, who will be glad to assist you. Write for our general catalogue, which shows in detail how to connect our wood pipe to valves, pumps, etc.

EAGLE PIPE SUPPLY CO., INC.

CABLE ADDRESS:
"Pipesuply, N. Y."
Western Union Code

General Offices
30 Church Street
NEW YORK. N. Y.

WAREHOUSE:
West Avenue and 6th Street
LONG ISLAND CITY, N. Y.

New and Second-Hand Pipe, New Mill Seconds and Contractors' Equipment

TRADE-MARK

Products

New Pipe, New Mill Seconds, and Second-Hand Steel and Iron Pipe, Casing and Boiler Tubes; Contractors' Equipment and Supplies.

.Service

This company maintains a large warehouse in Greater New York (Long Island City), which is well stocked with all sizes and kinds of pipe, ready for immediate shipment.

Modern equipment for the cutting and threading of all sizes of pipe to special specifications.

Shipping Facilities

Located on siding of Long Island Railroad and in close proximity to Pennsylvania and all other roads and steamship lines. All orders are immediately filled and shipped.

New Pipe

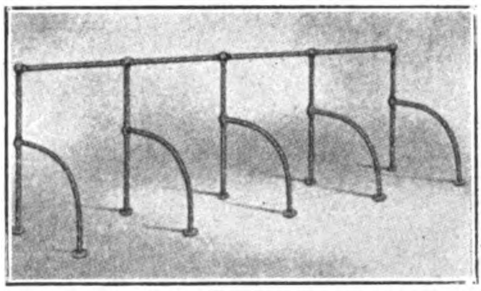
All sizes of new pipe are carried in stock, wrought iron and wrought steel, black and galvanized, for water, gas, steam, ammouia, sprinkler systems, etc.

New Mill Seconds

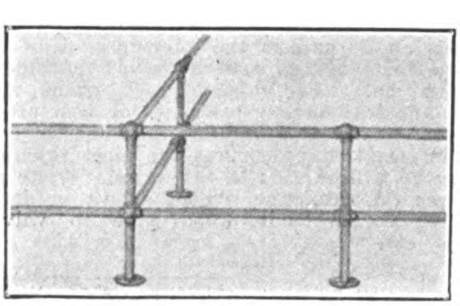
This class of pipe is carried in black and galvanized in sizes from three-eighths of an inch to twelve inches in diameter.

Recommended as most suitable and economical for the following purposes:

All structural and ornamental work, such as area, hand, and bridge railings, fence posts and columns. Extensively used in the manufacture of racks and stands of all kinds; tool handles; and as integral parts of various kinds of machines, etc. Also used as rollers and for cores in concrete work; also for conduit purposes. Larger sizes used for culvert purposes, conveying concrete, pile driving, etc.



New Mill Seconds Used for Stalls.



New Mill Seconds Used for Railings.

New Mill Seconds and Second-Hand Pipe Used for Columns and Supports.

Second-Hand Pipe

Second-hand pipe is extensively used in all kinds of mines, for air and water lines. Also for temporary and permanent discharge and exhaust lines, and for culverts. Largely used in all kinds of large and small industrial plants and in all classes of construction work. Also in connection with underground and overhead irrigation systems, and for artesian and other well drilling. Suitable for pile driving. In fact, can be used for almost any and every practical purpose to which new pipe or mill seconds are applied. Sizes carried in stock are from three-eighths of an inch to twenty-four inches in diameter. All second-hand pipe is in "A No. 1" serviceable condition, re-threaded and fitted with couplings. Material saving can be effected by its extensive use.

Second-Hand Pipe Used for Discharge Line.

Casings and Boiler Tubes

All sizes of casing are carried in stock, suitable for well drilling, etc. Casing, and second-hand boiler tubes, are suitable and extensively used in the manufacture of concrete filled columns. Second-hand boiler tubes cleaned and trimmed for re-tubing boilers.

Contractors' Equipment and Supplies

All kinds of second-hand machinery, tools and supplies used in connection with construction work, including boilers, hoisting engines, derricks, concrete mixers, air tanks, etc., are carried in stock. List and specification will be gladly mailed upon application. Inquiries are solicited. Will gladly quote on, and recommend material most suitable and practical for your particular requirements.

Buyers of Plants, Equipment, etc.

We buy up any and all large quantities of good serviceable new or second-hand pipe, as well as all kinds of plants and equipment.

THE LEADITE COMPANY, Inc.

1406 CHESTNUT ST., PHILADELPHIA, PA.

TRADE "LEADITE" MARK

REGISTERED U. S. PATENT OFFICE

For Jointing C. I. Water Mains

Products

Leadite is used for making joints in cast iron bell and spigot water mains. It is shipped in powder form in sacks containing 100 lbs. and barrels of 350 lbs. In making a Leadite joint, the joint is yarned up, and the Leadite is melted and poured into the joint, but requires no caulking.

Description

DURABILITY: Years of experience have proven that Leadite joints increase in strength with age.

NO CAULKING: Leadite joints require no caulking because the Leadite adheres to the pipe from the yarn out to face of bell, making a water-tight bond. However, a Leadite joint may be melted or cut out at any time if desired in making connections, etc.

COMPARATIVE QUANTITIES: One pound of Leadite is equivalent to four pounds of lead. It will be easy to figure the quantity of Leadite required for any given amount of pipe by referring to the reference table of relative quantities shown below, which is based on the joints being made the same depth with either material.

LABOR SAVING: Because it saves caulking charges, digging of large bell-holes, and reduces cost of trench pumping to the minimum, Leadite eliminates every superfluous operation in jointing cast iron water mains. The work is completed rapidly with the least amount of effort.

COST: When conditions are normal, Leadite saves at least 50% to 65% over lead, owing to the saving effected in material and labor. With prices of material and labor at a premium as they are to-day, the saving in favor of Leadite is much greater than this.

TOOLS: As no caulking is required, fewer tools are needed.

TRANSPORTATION: Considerable freight charges are saved because Leadite is lighter than lead.

HAULING: Saves hauling expense on the work because you move only one-fourth the weight of jointing material.

FUEL: Saves fuel because you melt only one pound of material instead of four, and only half as much heat is required to melt Leadite as is needed to melt lead.

DELIVERY: We can make prompt shipments.

DAMAGE SUITS: Claims for damages caused by joints blowing out are prevented because Leadite joints will not blow out under any pressure common in water works construction.

USERS: Progressive water works, mines, railroads, and industrial plants all over the country use Leadite, also the United States Government.

LEADITE REFERENCE TABLE

Approximate Quantities and Costs for making joints based on A. W. W. A. Standard Bell and Spigot C. I. Pipe

Nominal Diameter Pipe Inches	Material Pounds per Joint				Cost per Joint				Cost per Foot				Cost per Mile Based on 440 Joints				Nominal Diameter Pipe Inches
	Depth Inches	Lead	Leadite	Jute	Lead 5c	Leadite 10c	Jute 6c	Calking	Lead	Leadite	Jute	Calking	Lead	Leadite	Jute	Calking	
						**		**		**		**		**		**	
4	2.5	8	2.00	0.2	.40	.200	.012	.13	.033	.0166	.0010	.0106	176.00	88.00	5.28	55.97	4
6	2.5	11	2.75	0.3	.55	.275	.018	.13	.045	.0225	.0015	.0107	242.00	121.00	7.92	56.50	6
8	2.5	14	3.50	0.4	.70	.350	.024	.13	.058	.0290	.0020	.0108	308.00	154.00	10.56	57.02	8
10	2.5	17	4.25	0.5	.85	.425	.030	.13	.071	.0355	.0025	.0111	374.00	187.00	13.20	58.61	10
12	2.5	20	5.00	0.6	1.00	.500	.036	.14	.083	.0415	.0030	.0118	440.00	220.00	15.84	62.30	12
14	2.5	24	6.00	0.8	1.20	.600	.048	.17	.100	.0500	.0040	.0140	528.00	264.00	21.12	73.92	14
16	2.5	32	8.00	0.9	1.60	.800	.054	.19	.133	.0665	.0045	.0159	704.00	352.00	23.76	83.95	16
18	2.5	35	8.75	1.0	1.75	.875	.060	.24	.145	.0775	.0050	.0200	770.00	385.00	26.40	105.60	18
20	2.5	40	10.00	1.3	2.00	1.000	.078	.36	.166	.0830	.0065	.0301	880.00	440.00	34.32	158.93	20
24	2.5	48	12.00	1.5	2.40	1.200	.090	.42	.200	.1000	.0075	.0350	1,056.00	528.00	39.60	184.80	24
30	2.5	60	15.00	2.1	3.00	1.500	.126	.48	.250	.1250	.0105	.0400	1,320.00	660.00	55.44	211.20	30
36	2.5	75	18.75	3.0	3.75	1.875	.180	.54	.312	.1560	.0150	.0450	1,650.00	825.00	79.20	237.60	36
48	2.5	120	30.00	4.4	6.00	3.000	.264	.60	.500	.2500	.0220	.0500	2,640.00	1,320.00	116.16	264.00	48

**To compute the saving effected by using Leadite: Add the cost of Leadite to the cost of Caulking, plus one cent (.01) per foot for bell-holes, and an allowance for reduction in fuel, trench pumping and hauling charges, etc.
Leadite requires no caulking.

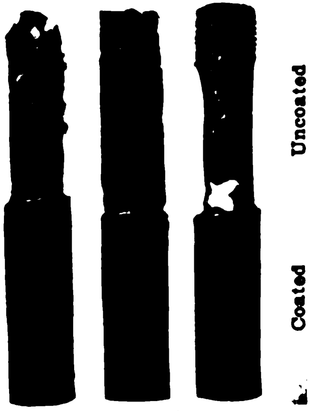
THE HIGHLAND CHEMICAL PRODUCTS CO.

CONNELLSVILLE, PA.

Highland Non-Corrosive Coating.

Products

That trade-mark stands for something more than mere paint. It **guarantees** actual protection from corrosion, or we forfeit payment for it. Highland Non-Corrosive Coating (Nos. 1 and 2) holds corrosion in check on structural steel, roofs, sidings, air and water pipe, tanks, pumps, steel ties, steel mine timbers cars, trolley poles, conduits, fans, cages, and water hoists. It also prevents the disintegration of concrete. In brief, wherever corrosion flourishes it will curtail its damage. You may order it with the understanding that if you are not satisfied with results, you need not pay for the goods.



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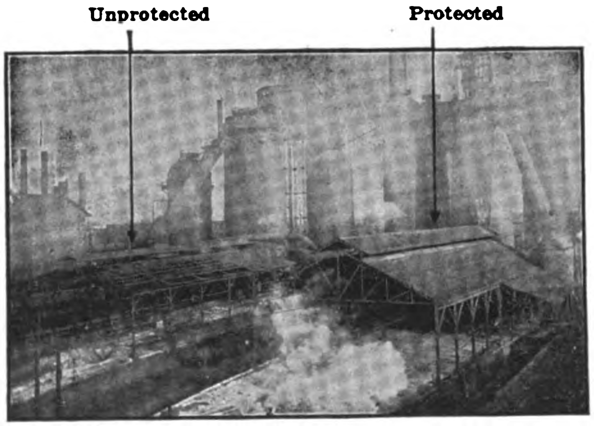
Protective Paints

Highland Non-Corrosive Coating is of three grades.

Highland Non-Corrosive Coating No. 1.—Is for general structural iron painting, for lasting and entirely satisfactory results. It is guaranteed to prevent rapid corrosion on tipples, fan houses, etc., caused by coke smoke.

Highland Non-Corrosive Coating No. 2.—Is for pipe lines and other underground work where the surface coated does not come in contact with daylight.

Highland Structural Coating.—Is for general structural iron pointing, but is not guaranteed to give the lasting results obtained from No. 1. It is for buildings, roofs, stacks, etc., where the use of the highest grade paint is not justified.



The corroded roof was painted with ordinary paint. The other was coated five years previous with Highland Coating. The whole story of waste and economy is told by this actual example.

Highland Paint

This paint is made to meet the demands for a low price paint and to protect our customers against inferior and injurious goods placed on the market as "secret process" or "newly discovered gums" with claims and guarantees that are impossible. Highland Paint is made from substantial materials, carefully selected, and will give satisfactory results. We can safely say it is the best that can be produced for the money.

A Copy of "The Sulphurette" Is Yours—

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"The Sulphurette—and It's Finish" is the title of a booklet that every mining man should have. It's full of boiled-down meaty, interesting **facts.**

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MINING MACHINE SECTION

Treatise
and
Engineering Data

Chart—Cost of Coal.
Specification Data for Mining Machines.
Coal Production for Various Thickness of Seams.

The following manufacturers have catalogue descriptions in this section:

Buettner & Shelburne Machine Co.
Empire Chemical Co.
Fairmont Mining Machinery Co.
General Electric Co.
Goodman Mfg. Co.
Howells Mining Drill Co.
Ingersoll-Rand Co.
Jeffrey Mfg. Co.
Lake Shore Engine Works.
Morgan-Gardner Electric Co.
Myers-Whaley Co., Inc.
Pneumelectric Machine Co.
Prox, Frank, Co.
Scranton Electric Construction Co.
Sullivan Machinery Co.
Thew Automatic Shovel Co.
Tracy, Bertrand P.

For additional descriptions of Mining Machinery and Equipment, not appearing in this section, refer to Index of Products in front of book.

COAL-CUTTING AND LOADING MACHINERY

By E. N. Zern, E. M.*

Mining machines are fundamentally labor and cost saving devices. Their introduction into American mines, now, as in the past, is to be ascribed to the constantly increasing demand for coal, the insufficiency of labor with which to meet this demand, and the characteristic propensity of the American to substitute mechanical for hand methods as a means of attaining greater production and economy.

With the growth of the markets for coal, the inadequacy of the labor supply has constantly plagued the operator. Even where this difficulty is not present, the disadvantage persists that much of the available supply is unskilled and of a roving disposition, given to wandering aimlessly from mine to mine. The assembly of an organization, whereby the combined efficiency of all units might be pointed toward a larger production, with its attendant economies, is thus largely frustrated. Moreover, labor has all along been insistent in its demand for increased wages, while, except during periods of abnormal activity, the selling price of coal has shown a slowly rising tendency, this largely because of the low production costs at new mines being opened. The necessity for greater outputs and the clamor of the workmen for higher wages encouraged the search for a means to increase production and reduce costs. Recourse was naturally had to machinery—a trend discernable in the development of all great industries.

Mining machines to-day produce about 60 per cent. of the nation's coal output. This compares with 35 per cent. in 1907. The advantages over hand mining may be summed up briefly as follows: first, the actual cost of mining is lower, due to the fact that the greater cutting capacity of the machine makes possible a greater output with a given labor cost; second, the quality of the product is superior, brought about by the deeper and more uniform undercut of the machine, which increases the percentage of lump coal 10 to 30 per cent. over hand mining methods; third, the industry is attended with less danger, since decrease in the amount of powder required when the coal is properly undermined reduces the danger from explosions attendant upon a blown-out shot; fourth, the mine may be more rapidly developed due to the much greater speed with which entries can be driven with machines. This quickens a return on the capital invested; fifth, the ability to mine seams in which the height of the coal, or the character of the roof, has prevented mining by hand, on a commercial basis; sixth, fewer men are needed in the industry. Machine mining encourages concentrated workings and intensive methods. Cases may be cited where with favorable conditions and a careful projection, systematically followed, an output of 20 tons per man per shift has been maintained.

Historical Development of Mining Machines

The first patent on a coal-cutting machine was issued to Michael Menzies of Newcastle-upon-Tyne in the year 1761. So much interest was aroused that in the century following more than 100 patents were taken out on mining machines. It was not, however, until about the year 1850 that the interest of the English coal operator was enlisted in the use of labor saving devices. The revolving-disk coal-cutting machines of Waring and Walker, introduced about this time, were really practical machines. The cutters on Walker's machine were each 2¾ inches long and were fixed on the periphery of a horizontal wheel which projected sufficiently beyond the side of the machine to cut a groove about 2 feet 4 inches in depth. The motive power, as in all the earlier types of cutters, was compressed air.

The early pick machine originated in the South Wales district. C. M. Percy, in his interesting account of the early mining machines, states †"it was a 'pick' machine, so called because the operating tool was a pick, and I suppose that the idea was to imitate the action of the collier's pick. Having always had a large amount of disrespect for the ordinary pick of the collier, in consequence of its wasteful influence upon the coal, I should not myself have directed my efforts in that direction; but there it was and we endeavored to cut the coal with this pick machine. The amount of success was very slight, and whilst we could not say on the one hand that the proportion of large coal was much increased, neither could we say that the expense of getting the coal was made any less, even without including the cost of plant, which was no slight matter, because we had not only the coal-cutting machines themselves, but we had long ranges of pipe to transmit the compressed air, and we had extravagant air compressors. The number of persons hovering about the machine, fixing it, working it, laying the road, would by hand have produced as much coal as the machine did. In this particular machine I am referring, of course, not to the chain arrangement, carrying several pick heads, which had made its appearance very early in the fifties, but a machine embodying a reciprocating movement similar to that administered to the ordinary hand pick by the collier."

One of the first machines was known as the "cutter-bar" type, using a cutter-bar as shown in Fig. 1. Cutting was done by bits held in the bar by means of set screws. A defect in this design was the manner of setting the bits so that there was no over-lapping. This made the work on each so severe that it was impossible to maintain them.

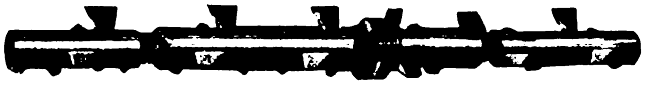

Fig. 1. Cutter-Bar Used on the First Coal-Cutting Machines.

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*Head of Mining Department, West Virginia University.
†Mines and Minerals, Vol. 23, pg. 565.

An additional defect was the reduction in diameter of the bar at two places which induced breakage at these points.

The Harrison puncher machine was introduced in the Dagus mines, Elk County, Pa., about 1880, and the Lechnor machine, a revolving bar cutter, was introduced about the same time at the New Catfish mine, Clarion County, Pa.

A machine of much historical interest, inasmuch as it illustrates the eagerness to apply electricity instead of compressed air as a motive power, is the Sperry Electrical Coal Digger, shown in Fig. 2. The operation, in brief, is as follows: *the motor is geared to a cam which is bound to the projectile by a strap. When the projectile is thrown out to its full length, the cam is over nearest to it. As it is drawn away the strap draws in the projectile and compresses the spring. The instant the dead center is passed the spring throws out the projectile. The cam is constantly revolving and picks up the strap when it comes round to it. It has a 6 inch stroke and this is delivered with a rapidity varying from 150 to 300 blows per minute.

The chain machine carrying a large number of pick points made its appearance early in the fifties. From that early day down to the present it has undergone many changes in design tending to fit it better for the varying conditions found in coal seams, thus evolving the modern types which will be discussed under their respective heads.

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*From an account in the Electrical World, March 23rd, 1889.

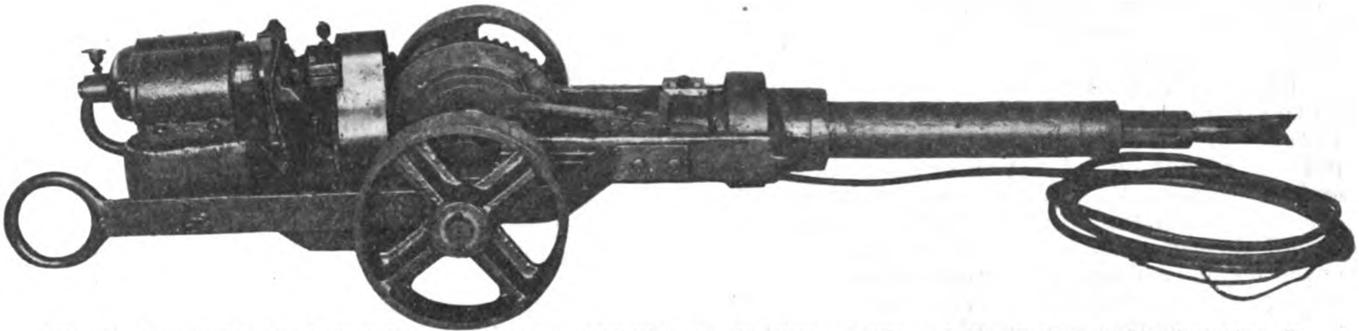

Fig. 2. Sperry Electrical Coal Digger. Now on exhibition in the Chicago office of the Goodman Manufacturing Co.

MODERN TYPES OF UNDERCUTTERS

Under this head will be discussed the four types of machinery used in the undercutting of coal; first, the pick, or puncher machine, having a reciprocating motion and striking a blow against the coal, not unlike that of the miner's pick; second, the chain machine in which the cutting is done by chisel or pick pointed bits, held rigidly in an endless chain, which revolves about a frame, capable of being fed into and under the coal; third, the disk machine, wherein the bits are placed on the periphery of a horizontal circular disk, the whole being not unlike a large circular saw, cutting being done by advancing the disk into and under the coal, and then along the face of the seam; and fourth, the cutter-bar machine, wherein the bits are held by set screws in a horizontal bar placed at right angles to the machine, cutting being done by advancing the bar into the coal and then along the face.

Pick or Puncher Machines

While puncher machines may be used for meeting the same mining conditions with a moderate capacity under which any of the other types can operate, they are particularly adapted for successfully overcoming obstacles which may cause the other types to fail. Mining conditions are always to be considered preliminary to the choice of any type of machine. These may be enumerated as follows:

First, Hardness of the Coal. Difficulty in mining coal is largely dependent on the prominence of the cleats. In general, it may be stated that coals having two well defined cleats, as, for example, the New River coals of West Virginia, are easily mined; coals having one well defined and one poorly defined cleat, as with the Pittsburg coal and some of the coals of Western Kentucky, are of medium hardness, while coals having no cleats, as anthracite, are hard to mine.

Exceptions to this latter statement may be noted, as in certain of the Tennessee coals and coal from the Georges Creek basin of Maryland. Frequently in coals having two well defined cleats, and also where the coal is naturally hard but very gaseous, so that the pressure of the gas has caused separation along the cleavage planes, there is a tendency to settle when the kerf is made by the cutter. When this happens the breast machine is firmly held by the weight of the loose coal and all advance is stopped. Often this requires that the machine be dug out. The puncher machine lends itself well to this contingency, withdrawal from under the settled mass being fairly easy of accomplishment.

Second, The Location of Impurities. This has much to do with the success of undercutting. It is a characteristic of some seams that boulders, or iron pyrite concretions are found lying close to the bottom. Here the chain or disk machine is severely tested, the bits being broken or dulled, and requiring that the cutter be withdrawn from the cut and the damaged bits be replaced, the operation being repeated as often as necessary. To cut through requires a heavy machine with a seven position chain so that the bite of each bit and the corresponding strain is reduced. When the pyrite is in concretionary form, pick pointed bits are used in preference to the chisel points, since the latter take too great a bite and are liable to place an excessive load on the motor. Where this trouble is especially pronounced, the puncher may be used to advantage since it is easily directed and the concretion may be cut around and removed.

Third, Conditions of Top and Bottom. Bad top conditions, up to the time of introduction of the short wall or continuous cutters, had a great influence in the selection of puncher machines. With the early general use of the chain breast machine, wherein the rear end of the frame was made firm by the aid of a jack pipe, one end of which butted against the roof, the frailty of the top was often such as to preclude the use of this type of machine, because of the severe vibrations in the jack pipe and the attendant dangers of roof falls. Furthermore, because of its mode of operation, the chain breast machine required from 10 to 14 feet of clear space along the face of the coal, leaving impossible of support a dangerously large area, especially where slips occurred in the roof. Neither of these disadvantages are found in using the modern machine of today, but in earlier times the use of the puncher machine was the only recourse for their avoidance.

In the same way may be mention the influence of bad bottom conditions. The breast machine carries the kerf in a straight line into the coal, penetrating rolls which rise in its path. For bottom cutting, puncher machines have an undoubted advantage in seams characterized by irregularities because of the greater flexibility of operation, enabling cutting to be done over and across the roll.

Fourth, Pitch of Seam. Where coal is worked on the room and pillar system it becomes necessary to transfer the machine from room to room for the purpose of cutting. A flat seam lends itself best to such movement. With inclined seams, where entries are driven on the dip and rooms on the strike, trouble is met with in moving the machine on the entries and in keeping it from slipping down hill while cutting in the rooms. The degree of difficulty encountered depends upon the amount of inclination. Here again it is observed that in the early days, the puncher machine type, owing to its advantage in portability, had the field supremely unto itself. While cases will be cited later, in the discussion of continuous cutting machines, where such are used for cutting highly inclined seams, it still holds true that the post puncher type predominates where moderately high pitching seams are undercut.

Fifth, the Drawing of Pillars. The adaptation of cutting machines to the work of taking out the pillars between rooms and entries has ever been in the minds of mining men. It is generally recognized that pillar work should commence as soon as the rooms are driven to their limit, and that for economical reasons, for securing a large percentage of recovery, and for the safety of the men, pillars should be drawn rapidly and systematically. With mining projections as frequently followed, the width of the room is so great and the pillar so narrow that its extraction produces a large area with insufficient support to maintain the face of the pillar accessible for machine work. Since the puncher machine permits props within 5 to 8 feet from the face it has always been the more favorably regarded for work of this kind, though it is true that the continuous cutter type has practically the same advantage and is being used in the systems of mining adapted to the extraction of rib coal.

There are, moreover, several features favorable to the puncher machine in comparison with any of the chain cutter types. First, cheapness, the ratio of first cost being about 1-4, 1-6, and 1-10 that of the chain breast, shortwall and overcutting machines respectively; second, the puncher may be more easily moved from place to place without the requirement of mechanical power; third, it is mechanically a simpler machine; fourth, it makes a wedge shaped cut, tapering from 12 to 18 inches in front down to 2 or 3 inches in back, whereas the chain machine cuts a kerf uniformly about 4 inches in height. See Fig. 3. This is productive of more lump coal upon shooting since it requires less powder to bring down the coal; fifth, the puncher cuts the coal down to the pavement, whereas the chain machine cutting at the bottom sometimes leaves a wedge shaped piece of coal which has to be recovered by hand digging, or else it lost; sixth, where compressed air is used in the operation of the puncher there is no danger from the ignition of gas as with electrically operated machines, unless equipped with explosion-proof motor casing.

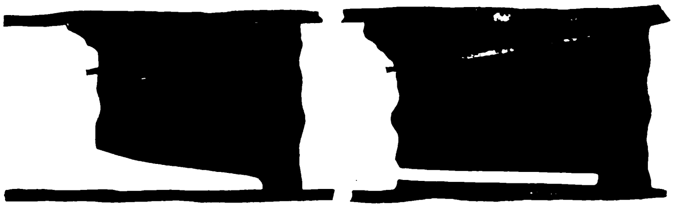

Fig. 3. Comparison of Puncher and Chain Machine Undercuts.

The disadvantages in the use of punchers may be said to be, first, the use, generally, of compressed air, which, because of its inflexibility as a power medium, lacks the popularity of electricity; second, a fewer number of places per shift can be cut than with the modern type of chain machine; third, their capacity being limited, the cost of cutting is higher; fourth, continuous cutting is not attainable though movement from cut to cut is rapidly made; fifth, the physical strain on the operator due to vibration and recoil is much more severe than with the modern machines.

The Compressed Air Puncher

The greatest usefulness for this machine is in horizontal seams though it may be used in undercutting where the pitch does not exceed 15 degrees. Compressed air is brought to the puncher from a near-by pipe line through a strong rubber hose and delivered to the valve chest. The blow is produced by the reciprocation of the piston in the cylinder and is directed by a sidewise movement and by tilting the machine up or down. The rate of speed is

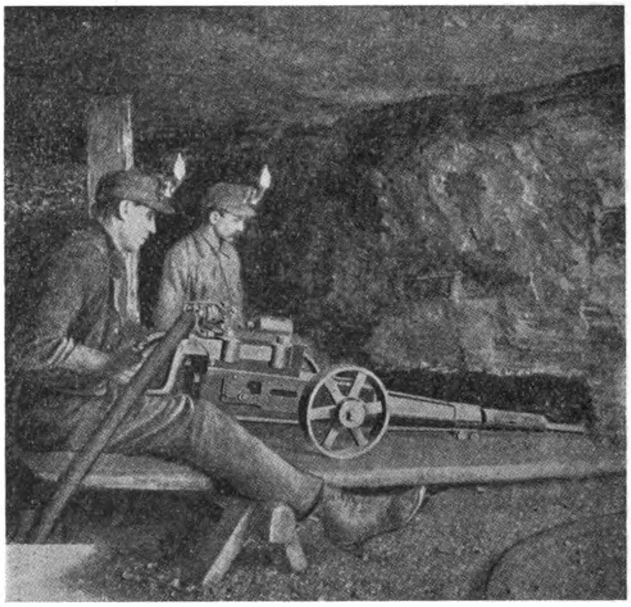

Fig. 4. Coal Puncher At Work.

such as to enable the operator to direct each blow at the desired spot. The board on which rests both machine and operator is inclined at a sufficient angle to keep the machine up to the face. See Fig. 4.

Steadiness and direction are effected by blocking the wheels on which the puncher is supported by means of wooden clogs loosely attached to the foot of the operator. The depth of undercut is from 4½ to 6 feet. The valve motion of the machine shown in Fig. 5 is independent of the travel of the piston. Its essential parts are two "spool" or plunger valves, air actuated, ground to a plug fit in the chest and each carrying a D valve. One is the "auxiliary" valve, its movement governing the other, or "main" valve, which in turn controls the admission and exhaust to the cylinder. The plungers cushion on air. The back port of the main valve is larger than the front, producing a forward blow that is much quicker and heavier than the backward pull, and moreover effecting an economy in the use of air. In case the blow misses the coal, the piston runs forward until an air cushion is formed, preventing the striking of the cylinder front.

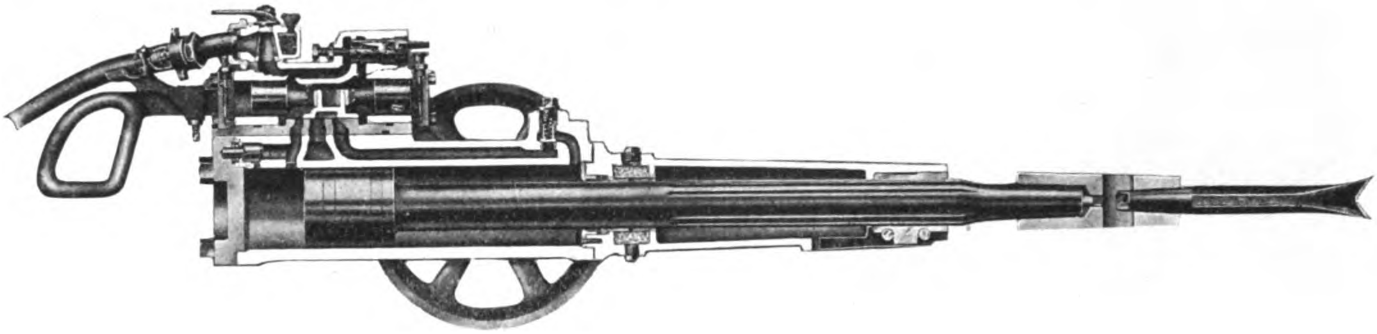

Fig. 5. Longitudinal Section of Coal Puncher.

The Electric Puncher

Because of the increasing use of electricity in mining operations many attempts to devise an electrical drill have been made, typical of which has been mentioned the Sperry machine, in which a motor was used to compress a spring, the rapid release being depended upon to drive the pick against the coal. Some of the early drills were crank driven. A more common principle was the solenoid such as in the Marvin drill, alternating fields being produced by means of special attachments to direct current generators.

None of these met with extended success, the principal difficulty with the solenoid drill being the extreme heat produced in the winding and core of the magnet, causing large power losses and the deterioration of the insulating material. A different principle—that of employing a machine in which electricity is utilized for the compression of air which, in turn, is used to drive forward the piston containing the pick—is found in the Pneumelectric puncher shown in section in Fig. 6.

This machine has many points in common with the straight compressed-air type, such as the air cylinder, front head, general outline and mounting. The points at variance are the electric motor which, in a way, takes the place of the valve chest and mechanism, and the use of two pistons instead of one. Power is generated during the retracting stroke of the motor driven piston, this power being in the form of compressed air which, after compression, is led through ports to the rear of the forward piston and causes the striking of the blow. The motor driven piston follows as the blow is being struck, the air between the pistons above a given pressure being allowed to escape through a so-called vacuum valve. The return stroke of the forward piston is effected by the suction of the rear piston. One of the many novel and ingenious features of the puncher is the manner in which the rotation of the motor is converted into reciprocating motion for the drill, this being done by a series of gears driven by the armature pinion.

Post Punchers; Mounted Pick Machines

Puncher machines on wheels cannot successfully undermine in a seam of coal with a pitch exceeding 15 degrees owing to the difficulty in handling. The mounted pick type of machine, being light in weight and easily transferred from place to place, is particularly adapted for cutting steeply pitching seams, a number being in use in mines where the coal pitches at an angle of 38 degrees and is 4½ feet high.

The machine looks like a rock drill and is handled like one, being mounted on a post as in Fig. 7, and thus deriving its name. The mounting may be a single or double screw column in varying lengths and for use is set normal to the bedding plane. The drill is held to the mounting by a clamp

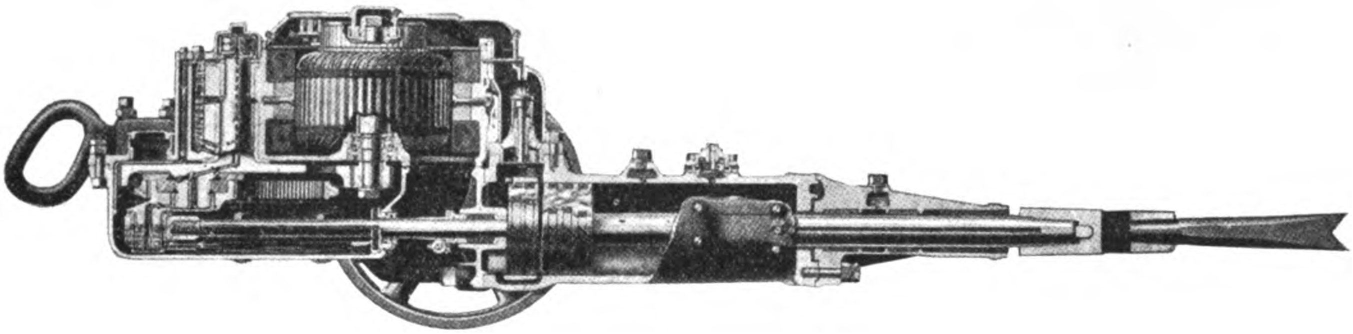

Fig. 6. Cross Section of the Pneumelectric Machine.

or collar and may be swung from side to side by means of a segment and worm. From three to seven cutting points are used in the bit depending on conditions and produces a kerf from two to six and one-half inches as may be desired.

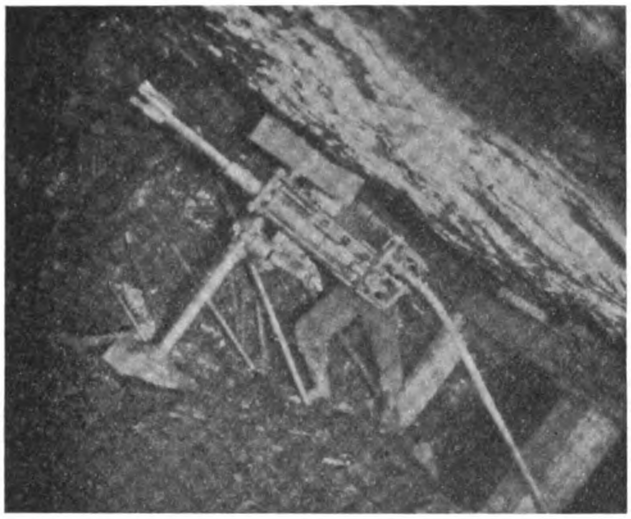
Fig. 7. Post Puncher Starting Mining.

Post punchers, in addition to their adaptability for pitching seams, are successfully used for shearing the coal before shooting. Owing to their manner of suspension they can mine at any height of the seam for the purpose of cutting out bands of fire-clay or slate in the coal.

Portable Compressors

For electrically equipped mines where it is desired to use air-driven punchers or drills there is available the portable compressor driven by an electric motor. See Fig. 8. The entire outfit is mounted on a truck and is easily moved from place to place. With this outfit it is possible to enjoy the advantages of compressed air for certain operations, such as, brushing top, driving tunnels, drilling roof for overcasts, bottom for sumps, etc., without undergoing the expense of a permanent compressing plant on the outside.

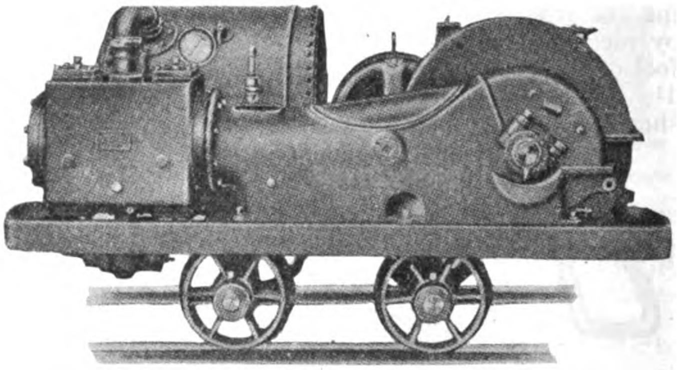
Fig. 8. Portable Electrically-Driven Air Compressors.

UNDERCUTTERS WITH REVOLVING CHAINS.

The Breast Machine

The chain-breast machine is the prototype of the modern chain machine and up to 1912 held predominance in numbers over all other types combined. Through a long period of years it has proved its adaptability for effective and efficient service under a wide variety of conditions. It consists essentially of a stationary, or outside, frame, an inside, or cutter frame, and the driving mechanism. The latter is usually an electric motor designed either for direct or alternating current, although in place of electricity, compressed air may be used to drive a pair of engines. See Figs. 9 and 10.

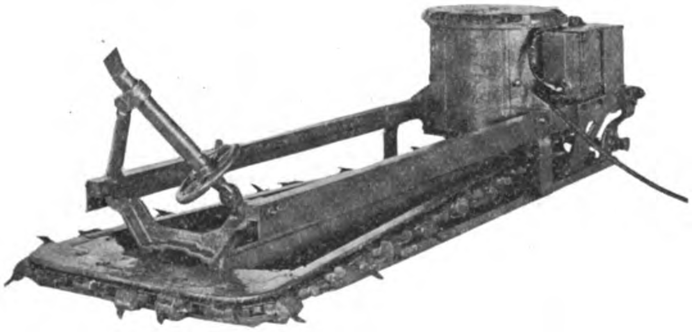
Fig. 9. Chain Machine Using Alternating Current.

The cutter frame is triangular in shape and contains two idler sprockets in the base of the triangle and a driving sprocket at the apex. The revolving chain, made up alternately of solid links and connecting straps, travels on these sprockets in its course about the cutter frame. Bits, made of tool steel, are set in the blocks and held in position with set screws. The openings in the chain links are arranged at such angles that either chisel or straight pick pointed bits, or combinations of both, may be used, depending on the character of the cutting. The base of the triangle, which first enters the coal, is made in widths varying from 39 to 44 inches, the smaller size being used for hard cutting conditions, while the latter is recommended for all ordinary usage. The outer frame carries a rack which meshes with a pinion driven by the motor and feeds the cutter frame under and into the coal.

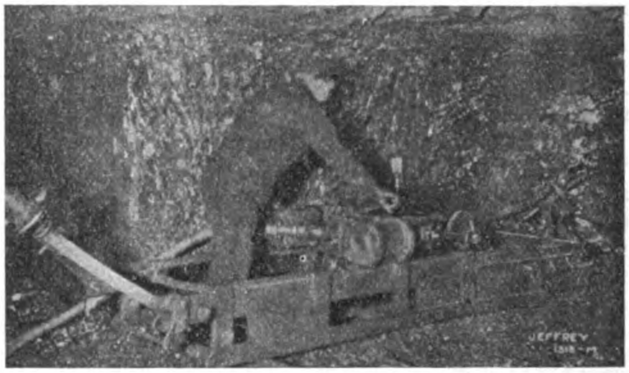

Fig. 10. Compressed-Air Machine Finishing First Cut on Left-hand Rib.

By means of suitable gearing interposed between the motor armature and the driving sprocket, the chain is revolved counter clock-wies. For operation, the machine is set up at the left hand rib for the first, or sumping cut. By means of a short fork jack, the front end is prevented being thrust away from the normal position by the action of the bits biting into the coal. The rear end is held rigid by a jack pipe running from the roof to the stem of an inverted Y brace spanning the machine. See Fig. 10.

On the completion of the first undercut, which may be from 5 to 7 feet in depth, depending upon the height of the seam, and may require from 4 to 5 minutes in clean coal, the cutter frame is completely withdrawn, the jacks removed, and the machine barred to the right a distance equal to the width of the cut. This movement is facilitated by skids placed at the front and rear beneath the machine. Cutting, withdrawing and barring are repeated until the entire width of working place is undercut. On the completion of the last cut, the machine is barred into position for placing on the truck preliminary to moving to another place. Movement of the truck may be either by animal power or by the machine motor itself. The latter is by far the most usual manner as delays in waiting for the driver are avoided.

The ideal conditions for a chain-breast cutter are (1) a horizontal seam, (2) an even and regular bottom with an absence of rolls, horsebacks, faults or erosion, clay veins, pyrite concretions, etc., (3) a good top capable of self-sustaining at distances sufficient to permit travel of the cutting machine across the face, (4) ample thickness of seam to expedite the movement of the machine in cutting, and from room to room.

While it is true that the merits of the present day machines have robbed the chain breast machine of its early prestige, there are unquestionably situations in which it gives better results than any other type. There are conditions which may be met equally well by the breast machine and the other types; and there certainly are conditions to which the breast machine is wholly unsuited. Experience has proven that for each type there are advantages so that any will show a superior performance under those certain conditions for which it is best adapted.

CONTINUOUS CUTTER OR SHORTWALL MACHINE

This type of cutter is a development of recent years and is designed to avoid most of the disadvantages associated with the use of the chain breast and puncher machines. The popularity of this type may be ascribed to the following favorable features: (1) the method of operation of the machine enables it to maintain a much higher cutting speed than is possible with the breast machine or with the puncher; (2) it is safer to operate because it is so compact that props may be set permanently within 6 feet of the face, the machine passing between them and the face while cutting across the room; (3) in tender coal, which has a tendency to settle while being cut, the narrow solid cutter bar, combined with the method of operation, permit the machine to proceed without delay, cutting itself free in most cases; (4) the continuous cutter moves uniformly along the floor, making an open cut with no ribs or sprags at the back to hinder shooting; (5) its flexibility permits it to follow rolls or irregularities in the floor readily, in which it stands second only to the puncher; (6) the small space required

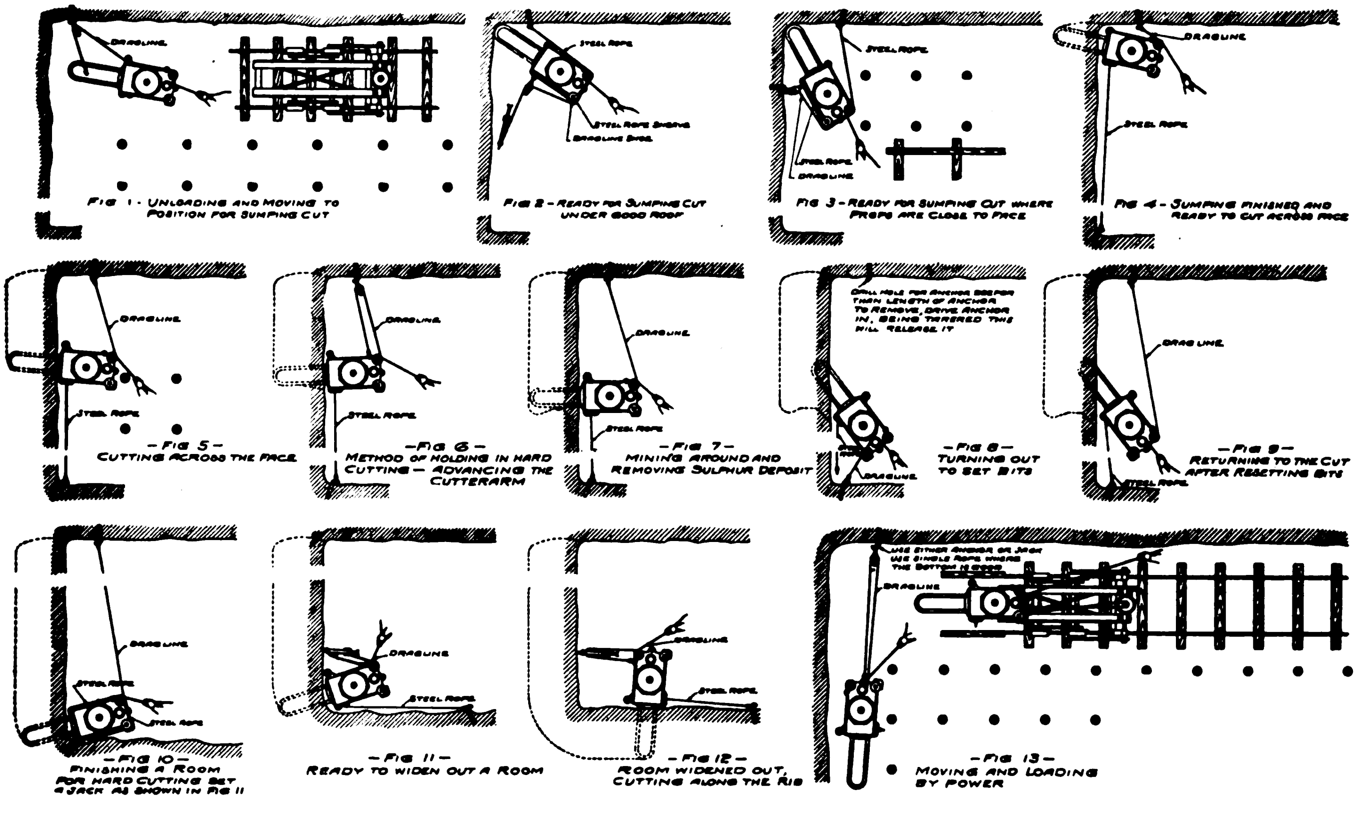
DRAGLINE
STEEL ROPE
STEEL ROPE SHEAVE
DRAGLINE SHOE
Drill hole for anchor deeper than length of anchor to remove, drive anchor in, being tapered this will release it
Use either anchor or jack use single rope where the bottom is good

Fig 1 - Unloading and Moving to Position for Sumping Cut

Fig 2 - Ready for Sumping Cut under Good Roof

Fig 3 - Ready for Sumping Cut where Props are Close to Face

Fig 4 - Sumping Finished and Ready to Cut Across Face

– Fig 5 – Cutting Across the Face

– Fig 6 – Method of Holding in Hard Cutting – Advancing the Cutterarm

– Fig 7 – Mining Around and Removing Sulphur Deposit

– Fig 8 – Turning Out to Set Bits

– Fig 9 – Returning to the Cut after Resetting Bits

– Fig 10 – Finishing a Room for Hard Cutting Set a Jack as Shown in Fig 11

– Fig 11 – Ready to Widen Out a Room

– Fig 12 – Room Widened Out, Cutting Along the Rib

– Fig 13 – Moving and Loading by Power

Figures 1 to 13—Typical settings and operations of the Short Wall Machine.

Fig. 11. Typical Settings and Operations of the Shortwall Machine.

in front of the face allows the track to be brought closer thus facilitating loading of the coal; (7) manual labor is reduced, since all movements of the machine, such as shifting, setting and travelling are made under its own power, making barring or heavy lifting unnecessary; (8) it lends itself to the use of a longer cutter bar than is feasible with the breast machine; (9) it is adaptable for cutting pitching seams; (10) it can be successfully used in drawing pillars; (11) because of its strong and compact build it is well fitted for cutting hard coals.

In operating the continuous cutter there is a constant repetition of a cycle of five operations: (1) unloading and dragging to the face; (2) sumping the cutter arm into the coal; (3) undercutting across the face; (4) dragging out and re-loading; (5) travelling to the next working place. The series of diagrams shown in Figure 11 illustrate the principal operations, with the variations necessary under certain conditions. This machine is built with a drag line made of wire rope, chain, or hemp.

Unloading from the truck and dragging to the face are done by one simple operation. A jack or anchor is set at the right hand rib near the face and the drag line connected as shown in the first diagram of Figure 11, and also in Figure 12, with a few wraps around the winch head. Upon starting the motor, the machine slides off the truck and is drawn toward the corner of the room where its work is to begin. By combinations with a snatch block, the machine may be moved around as required and dragged into difficult positions around props, etc., moving entirely by its own power, at any speed and in any direction the runner desires.

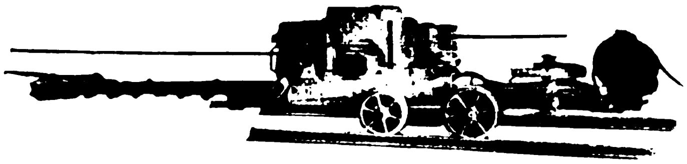

Fig. 12. Unloading From Truck By Means of the Drag Line Led Ahead Through a Snatch Block Attached to an Anchor or a Jack.

After the sumping cut has been made, the steel rope is carried directly from the feed drum across the room to a jack or anchor at the left-hand corner as shown by Fig. 4 in the diagram. The drag line is attached to the jack or anchor in the right-hand rib, lately used for the steel rope while sumping, and a few wraps are taken on the snubbing post. This completes the arrangement of cables for cutting across the face.

The runner has perfect control of the machine as it cuts its way across the room. He holds the drag line in his hand and can regulate at will the rate at which it is paid out around and from the snubbing post as the steel rope draws the machine steadily across the face, as in Figure 5 of the diagram. When the cutting has been completed the machine is drawn by its own power across the floor and swung into position for loading. The truck is rolled forward, its front end passing beneath lugs on the machine frame. The drag line is hooked to an eye on the machine, passed around a sheave on the truck drive gear and back to the winch head. Thus the machine is loaded quickly, and when made fast in position on the truck by the windlass chain, it is ready for the fifth operation, i. e., travelling to the next working place.

Length of Cutter Bar

An interesting development in the application of machinery to mining is the increased depth of undercut over the usual six feet so commonly found with the chain breast type. Experimental machines have been built with cutter bars 12 feet in length.

Under favorable conditions they are being successfully used in length of 8 feet 6 inches, and 10 feet 4 inches. Other than the increased length of cutter bar, the machine is identical with the standard type using 5½ or 6½ foot bars. These machines are fed under the coal and across the face of the room with a rope or chain and will cut either from right to left or left to right. After a thorough test with long cutter bars, the following results were evident: *Comparing the ten-foot four-inch bar with the 6½-foot bar, the longer bar cut 64 per cent. more coal in the same places, cost only about one-third more for labor and power, required fewer repairs per ton, produced a larger percentage of lump coal, and required less powder per ton. Moreover, the development progress is materially increased by the long bar machines. An average advance of 160 feet per month was made with 6½-foot bars working single shift, while 250 feet is an average for the ten-foot four-inch bar during the same period. An undercut of ten feet has been made in seams only three feet six inches thick on the average. Fig. 13 shows the machine unloading from its self-propelled truck.

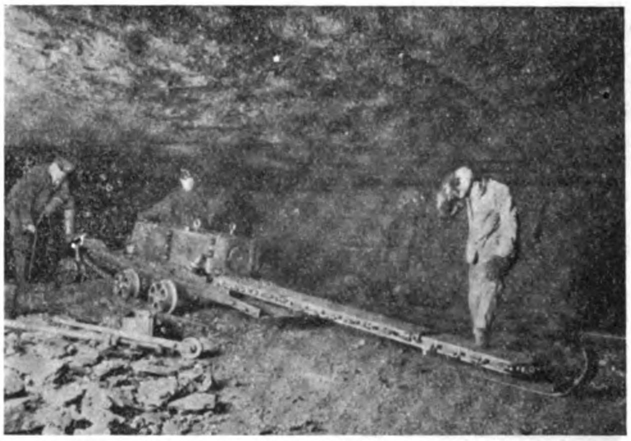

Fig. 13. Continuous Cutter with Ten-Foot Bar.

Cutting Inclined Seams

The continuous cutter, or shortwall machine, lends itself well to pitching seams. It has been operated successfully, and without extra labor, in rooms and entries driven across a pitch of 25 degrees, and in rooms and entries driven up a pitch of 20 degrees. Rooms are driven on the strike and shortwall machines are used. The sump cut is made at the low point of the room, the machine propelling itself up-hill, though no serious difficulty is encountered in cutting down.

The Roslyn seam in Washington varies in pitch from 8 to 20 degrees. Shortwall machines are in use at one mine, the rooms of which are driven on

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*From Mine and Quarry, January, 1916.

the pitch. Movement of the machine up the room was not possible when the grade encountered was 14 per cent. until intermediate gearing was placed on the self-propelling truck. Difficulty was also met with in unloading the machine from its truck because of the cutter bar teeth catching on the bottom. This was overcome with a simple device fitted to the cutter bar.

Drawing Pillars With Mining Machines

Upon the conclusive demonstration of economy and increased production through the use of mining machines for room and entry driving, attention was turned to their utilization for the drawing of ribs between the rooms. This was made the more desirable because of the particular nature of the work and the fact that in some districts the only labor available for it was principally foreign, hailing from central and southern Europe, and lacking the skill of the more experienced miner.

During the period when the puncher and chain breast machine only were available, experimenting was done mainly with the puncher, since the breast machine required too great a space between the timbers and the face and obliged the setting of the rear jack pipe against a roof already weakened by the withdrawal of the pillars. Little success attended these early efforts, one of the principal drawbacks being the method of working, this generally consisting of the driving of wide rooms with narrow pillars between. A second difficulty lay in the irregular manner in which rooms were driven, causing wide ribs at some points and narrow at others. The systematic and orderly drawing of ribs was conspicuously absent and under these conditions an unevenness of roof pressure resulted which proved inimical to machine work.

It has been since demonstrated that machines can be used successfully for the withdrawal of pillars when: (1) the workings are rigidly held to a preliminary projection thus insuring uniform thickness of rib; (2) the width of room is small as compared with the width of pillar; (3) a line of break is established and a reasonable diligence exercised in holding to it; (4) the drawing of the ribs is done rapidly and systematically, enabling an uninterrupted progression; (5) the ribs are cleanly drawn, permitting no stumps to retard the natural fall of the overlying strata; (6) the roof and bottom conditions are favorable.

The shortwall machine best answers the requirements for rib work—in fact in some districts the United Mine Workers of America specify shortwall machines and prohibit the use of chain breast machines. In one instance, where 90 per cent. of the panel is machine mined, all the coal is recovered by shortwall machines except small blocks left for pick mining. Rooms are driven on 60 feet centers, 21 feet of which represents the width of room. In another system, rooms are driven on 112 feet centers, with the room 12 feet wide. The large rib provides ample protection against the interruption of machine work by squeezes, creeps, falls of roof, etc. The shortwall machine used makes an undercut of 7 feet. At mines where there is a full equipment of mining machines the proportion of machine coal amounts to from 80 to 95 per cent. of the total output.

Undercutters In Anthracite Workings

In the earlier designs of machines the hardness of the coal had considerable to do with their adoption for mining, but as the demands increased for a type fitted for the hard seams, designers merely increased the strength of the cutter bar, cutter chain, gearing, frame, etc., with a corresponding change in the electric drive. Since 1910 the coal cutting machine has had a gradually increasing use in the thin seams of the anthracite region, cutting measures as low as 27 inches in thickness. Previous to the introduction of mining machines in these seams, the coal was shot from the solid, and being extremely hard and tight, the output per man was very low and the cost of explosives high. This coal undoubtedly represents the severest conditions to which mining machines may be subjected, but results here and elsewhere in the thin seams, flat, or up to an inclination of 20 degrees, have demonstrated that they bring the same beneficial results as in bituminous mining.

In the majority of cases the room and pillar system of mining is followed, thus providing protection to the overlying seams not completely mined. However, at several places the surface seam is being worked on a panel longwall system, cutting being done at night.

Both shortwall and longwall machines are used in the region. The latter is especially favored in low places, in some instances being used in seams which are only from 27 to 28 inches high. Props are placed within 3 feet of the face without interfering with machine operation, the usual allowance for the shortwall machine being 7 feet.

OVERCUTTING MACHINERY

The continuous cutter has removed, as was intended, a great many of the difficulties which beset the operation of the chain breast machine. It does not, however, eliminate removal from and to the truck, neither can it make its cut other than at the bottom of the seam.

Many coal seams have bands or impurities, varying in thickness from a fractional part of an inch to a foot or more. With the undercutting machine in use and the kerf close to the bottom, this foreign matter is intermingled with the rest of the coal after the place is shot. Separation of the impurity may be effected to some extent by hand picking before loading, but since this is seldom done satisfactorily, it is mainly accomplished on the tipple, in the course of preparation of the coals for market. It is evident that frequently this troublesome refuse could be eliminated if the cutting was done in the plane of the impurity. The question naturally arose, why not develop a cutter which does not require removal from the truck, and in addition can be used to cut out a dirt band in the seam? The answer to this is the overcutting type of machine as found to-day.

In this type the cutter is built on a self-propelling truck from which it is not removed when making a cut. The track is preferably placed in the center of the room, or where this is not practicable on account of stowing rubbish, the end of the track may be curved so as to bring the machine to the center of the face when ready for cutting. The height of the cut depends upon the location of the impurity, except in very high seams where the cut is made in the middle, each half being blown out in turn.

Additional advantages claimed for the overcutting type are (1) it will cut more coal in a given time, because of the elimination of various steps of operation required with the undercutting types. It is estimated that the capacity of an overcutter is three times that of a chain-breast machine and twice that of a shortwall machine; (2) on the above basis, it saves the wages of one to two operating crews; (3) the cost of up-keep and repairs for a given output is much less; (4) it drives straight entries, provided the track is laid straight; (5) less manual labor is involved in cutting; (6) the overcutting machine protects tender roof. The location of the kerf at the center or top of the seam makes it possible to use less powder for blasting and saves the roof from excessive jarring. If the cut is made at the top, all blasting is done from below the cut, affording the roof a maximum of protection; (7) more lump coal produced since the charges used in blasting are diminished; (8) because of this decrease the dangers from a blown-out shot are lessened; (9) when cutting in dirt seams the resulting fine dust is intimately mixed with earthy matter tending to make the coal dust less explosive; (10) in wet places there is no great inconvenience from water; (11) the method of operation insures greater personal safety to the machine runners.

The application of the overcutter to various mining conditions is clearly shown in Figures 14 and 15, and the operation of the machine is made clear by a study of Figure 16.

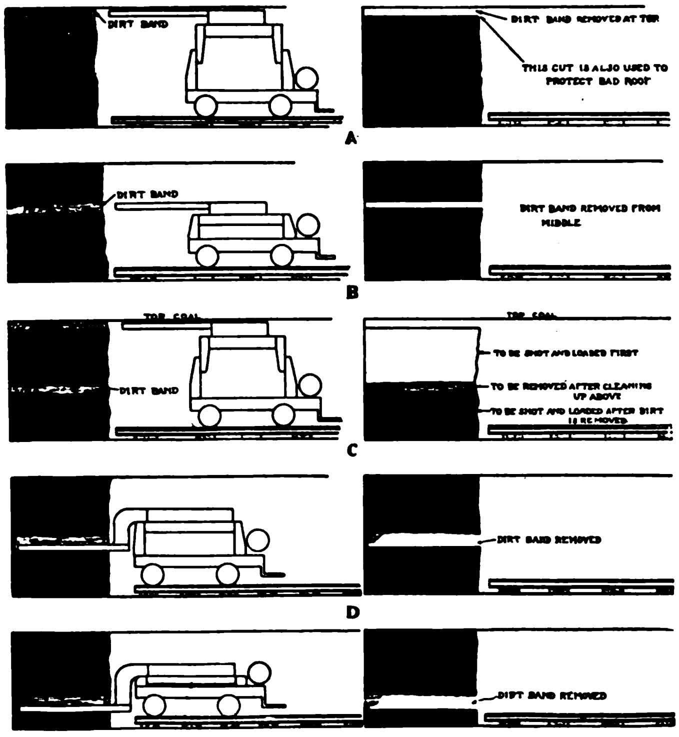

DIRT BAND
DIRT BAND REMOVED AT TOP
THIS CUT IS ALSO USED TO PROTECT BAD ROOF
A
DIRT BAND
DIRT BAND REMOVED FROM MIDDLE
B
TOP COAL
DIRT BAND
TOP COAL
TO BE SHOT AND LOADED FIRST
TO BE REMOVED AFTER CLEANING UP ABOVE
TO BE SHOT AND LOADED AFTER DIRT IS REMOVED
C
DIRT BAND REMOVED
D
DIRT BAND REMOVED
E

Fig. 14. Showing the Overcutter As Applied for Mining Out Dirt Bands Variously Located in the Seam.

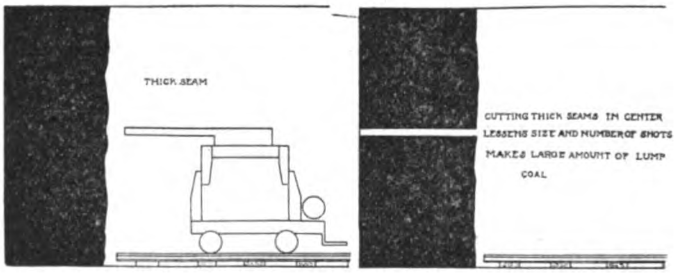
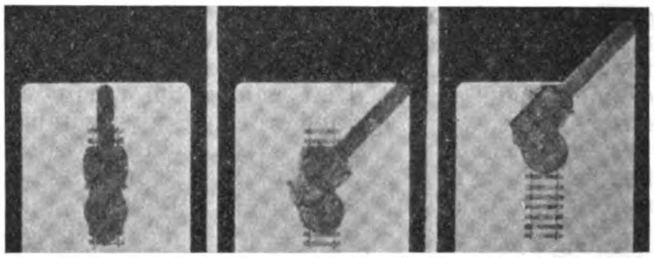
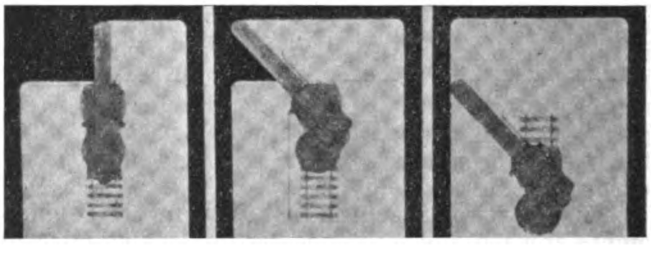

THICK SEAM
CUTTING THICK SEAMS IN CENTER
LESSENS SIZE AND NUMBER OF SHOTS
MAKES LARGE AMOUNT OF LUMP COAL

Fig. 15. Showing the Overcutter As Applied for Mining Thick Seams.



1. Traveling with its cutter arm in mid position the machine arrives at the face in the room.
2. Anchor hole is drilled (by power), anchor set, feed rope attached and cutter arm swung to the right-hand rib.
3. Cutter chain is started, and the cutter arm digs its way into the face as the feed rope is wound in.



4. Straight face cut is made by swinging the arm to the left, in which movement it is caused to withdraw by cam action in such manner as to maintain straight line cutting.
5. Face cut continues to left-hand rib, the cutter arm advancing by cam action to continue the straight face.
6. Cut finished by backing the machine along the track, using feed rope attached to a jack set behind.

Fig. 16. Showing the Various Operations In Overcutting.

LONGWALL COAL CUTTERS

Most of the early machines were fashioned for cutting longwall faces and this early type is commonly found in England to-day. It make a continuous cut, being propelled along the face on skids by a self-haulage mechanism. There are three classes of machines used; the disk, the chain, and the bar. In all of these the rotary cutter projects from the side of the machine to which it is attached by a bracket or other similar device. The main body of the machine carries the motor or engine, the gearing, and the controlling device.

The Disk Cutter

In this type the cutter consist of a large disk carrying cutting tools on its periphery and rotated by means of gearing. See Fig. 17. The motor is fixed at one end of the mechanism and the haulage gear at the other. This latter consists of a drum on which is wound one end of a flexible wire rope. The other end is passed around a snatch block attached to a post set some distance away in the direction of the advance, and is then returned to a hook on the frame of the machine. The travel of the cutter is effected by the winding of the rope on the drum which is driven by a pawl and ratchet device. The rate of advance can be adjusted to suit the cutting conditions.

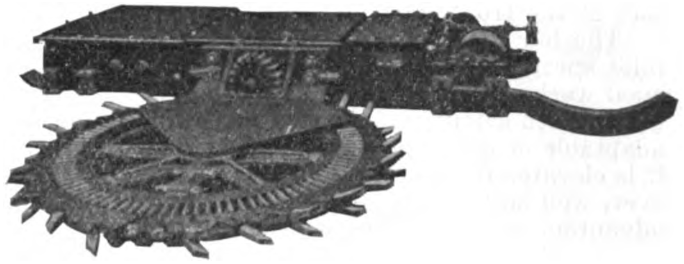


Fig. 17. Longwall Disk Cutter.

In traversing the face the machine is kept in position by guides fixed on either side, one sliding along the face and the other along a row of posts set parallel to the face. These guides counteract the tendency of the machine during cutting to drag in toward the face at the front end and thrust out against the props at the back. The reversal of the disk is a feature of the machine, making it possible to cut in either direction along the face.

The disk machine has great strength and is well adapted to cutting hard coal. In soft coal liable to settle, the disk is frequently stalled owing to the large area of exposure within the kerf. It has the disadvantage of being awkward to handle, and since there is little flexibility in its movement it does not work well where the floor is uneven.

The Chain Machine

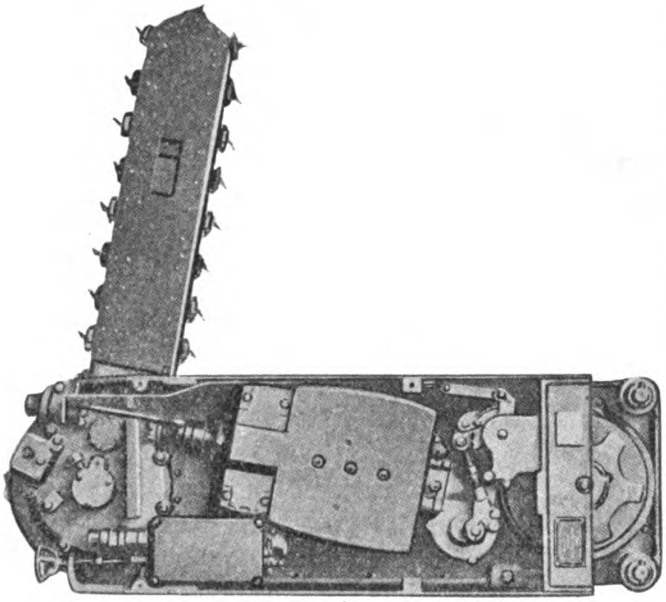


Fig. 18. Top View of Chain Longwall Machine.

This machine, a top view of which is shown in Fig. 18, has the same mechanical principles as the shortwall cutter, although the arrangement of the working parts is somewhat different in order to meet longwall conditions. As with the disk cutter, the chain machine is reversible. The cutter bar swings through an arc of 190 degrees so that it may be slewed in and out of the coal or round to the other side of the machine when a cut is started or finished, or when the machine is cutting in the opposite direction along the coal face. Under its own power, by means of a rope, it is sumped or cut under the coal from the loading position, in which the cutter bar is in line with the machine, changing to the cutting position in which the cutter bar is at right angles with the machine.

No track, guides, rails, or props are required to hold the machine up to the working face. It travels on a rope or chain stretched between two jacks. See Fig. 19. The angle of the machine, or cutter bar, together with the friction of the cutter bits against the coal holds the machine in line with the work at all times during the cut along the face. The machine is adapted to very thin seams of coal, its total height being about 18 inches. In width it measures as low as 27 inches so that props may be permanently set at a distance of less than three feet from the face.

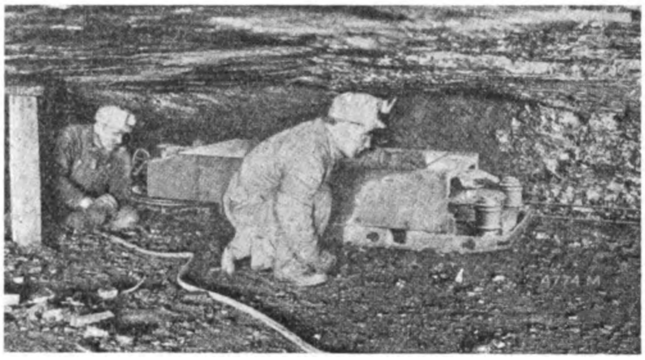


Fig. 19. Longwall Cutter Moving Along the Face.

The chain machine has an advantage in dealing with unevenness of floor owing to its greater flexibility as compared with the disk machine. The narrow width of the cutter arm gives it a double advantage in that the coal can be spragged close up to the solid and in case the coal should squeeze down the possibility of cramping is minimized.

The motive power for these machines may be either direct or alternating electric current, or compressed air. An air turbine is used on the air machines.

The Bar Machine

In this type cutting is done by means of a circular bar, tapering toward its outer end, and carrying bits which project radially from it. A spiral runs along the cutting portion. See Fig. 20. The bar rotates at a high speed, its cutting action resembling a side milling tool of great length and small diameter.

The circular head to which the bar is attached has two motions, one in a horizontal plane about its center line by which the cutter can be rotated

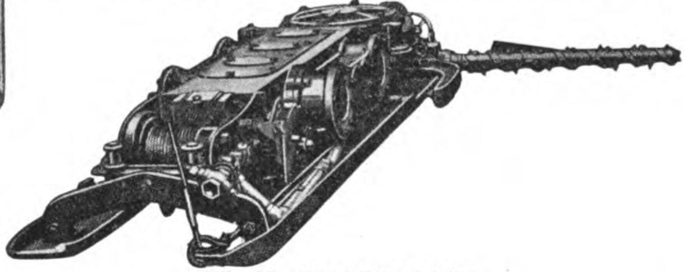


Fig. 20. The Bar Machine.

180 degrees, preliminary to the return along the face, like the cutter arm of the chain machine, and two, in a vertical plane, whereby the bar can be tilted and assisted in surmounting small obstacles in the seam with little difficulty.

Attached to the machine are skids made of angle iron on which the cutter slides along the face. The vertical flange of the outer angle also serves as a guide by gliding along the props set parallel to the face, while the inner has attached a guide to prevent the machine from drawing in toward the face at the front end.

The bar machine, like the chain machine, permits spragging almost up to the solid and can do good work with a rolling floor. No great difficulty is had with settling in tender coals. It is the most adaptable of all for overcutting, for which purpose it is elevated by mounting on skids. It is not, however, well suited for hard cutting and has the disadvantage of cutting an uneven bottom.

PERMISSIBLE COAL CUTTERS

In recognition of the danger involved in the use of electrically operated machinery in mines where explosive gases are liberated, manufacturers have placed on the market explosion-proof motors for use with coal-cutting machinery.

"The term 'explosion-proof' as applied by the Bureau of Mines to an electric motor, refers to a motor inclosed by a casing so constructed that an explosion of a mixture of mine gas (methane) and air within the casing will not ignite a mixture of the same gas surrounding the motor. There are two classes of motors so constructed; First, a totally inclosed class built strong enough to withstand high internal pressures and so designed that the efficiency of all inclosing covers can be satisfactorily maintained; second, a class provided with relief openings or valves designed to relieve the pressure of an explosion within the motor casing and to cool any products of combustion discharged within the valves. A satisfactory motor of the first class is much more expensive to build than an equally safe motor of the second class. For this reason, attempts to make motors explosion-proof have been confined chiefly to motors of the second class."*

The same principle as is found in all oil-safety lamps is relied on as the basis of most of the protective devices, that is, causing the discharged gases to pass over or through metallic plates or screens, which, by conduction, remove the heat from the gases before reaching the outside atmosphere. While it is true that the use of explosion-proof motors is a commendable precaution, it must be admitted, as stated by Mr. Clark, that "it is of little use to provide safe coal-cutting equipment if within the limits made dangerous by the presence of gas there are used in connection with the electrical equipment uninsulated wires, or wires not installed upon suitable insulators and in a first-class manner. The protection of the electrical system in gaseous mines must be made consistently complete."

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*Bureau of Mines Bulletin No. 46, "An Investigation of Explosion-Proof Motors," by H. H. Clark.

COAL LOADING MACHINERY; COMBINED CUTTING AND LOADING MACHINERY

The steady progression from pick mining to the puncher, chain-breast, shortwall and overcutting machines is suggestive of the further application of mechanical devices at the coal face. So long as the demands for coal are increasing and the shortage of labor supply continues, there will be unremitting search for a practical device that will not only cut the coal but will load it as well into the mine car. The fact is that such devices have appeared on several occasions in the past and are being successfully used in mines to-day. The first appearing of these were merely coal-loading machines and because of, (1) their great length—in one case up to 40 feet; (2) the failure to correctly proportion the parts carrying the severest strains; and (3) the lay out of the mine being poorly adapted, their use was attended with discouraging results.

In some of the later designs the coal is brought down by a puncher, which is an integral part of the mechanism, and as it falls to the bottom is caught by a pan, then passed to an elevator by which it is gradually elevated to mine car height at the rear of the machine, and then dropped into the car. Other types embody the chain-cutter principle. The coal is undercut by a regular chain-breast cutter bar, both sides of the cut being given a shearing cut, likewise by chain cutters. The coal thus freed is punched out by a mechanically operated pick and carried by a conveyor to a mine car at the rear.

NOTE—We are indebted to the following manufacturers for cuts and illustrations appearing in this article:

Goodman Manufacturing Company,
Ingersoll-Rand Company,
Morgan-Gardner Electric Company,
Sullivan Machinery Company,
The Jeffrey Manufacturing Company,
The Pneumelectric Machine Company.

Specification Data for Mining Machines

Type required

- Chain Breast
- Shortwall
- Overcutting
- Puncher—Air
- Puncher—Electric

Kind of Coal.
- Nature of cutting

Thickness of Vein.
- Maximum
- Minimum
- Average thickness

Location of impurities.

Kind of impurities.

Roof
- Rock
- Slate
- Wet
- Dry
- Height above rail in rooms . . ; in entries . .

How far back from face can posts be set?

No. Rooms opened up.
- Length
- Width

Nature of Bottom.

Voltage—character of current.

Distance from power plant to limit of workings.

Switch radius.

Clearance between rail and rib—entries.

Clearance between rail and rib—room necks.

Pick Rate

Pick yardage.

Machine yardage.

Rate per day—Runner—Scraper. Hours per shift.

Loading rate
- Shooting
- Propping
- Track Laying.

Will machines be used on ribs?

Type of Chain (4, 5, 6 or 7 bit)

Type of Bits (chisel or pick pointed)

Track gauge—Kind of rail (wood or steel)
- Location of track in rooms

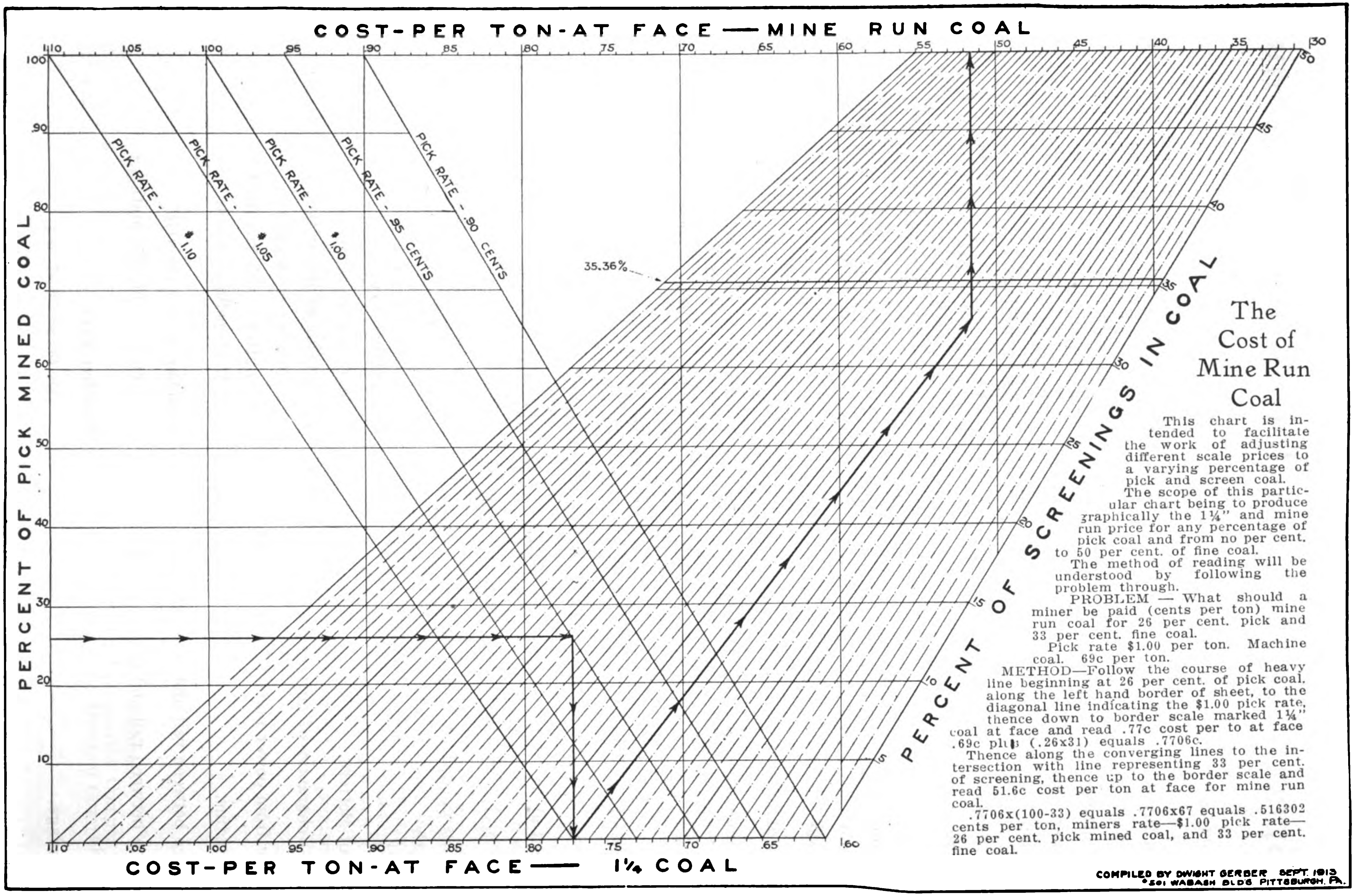
For Chain Breast Machines
- Cut—depth.
- Cut—width.
- Length of cable required.
- Open or closed type motor.
- Self propelling or not.

Shortwall Machine
- Depth of cut.
- Length of cable required.
- Self propelling or not.

Overcutting Type
- Width of place to be cut.
- Location of impurities.
- Character of impurities.
- Length of cable required.
- Self propelling or not.

Puncher Type—Electric
- (See General Information.)

Puncher Type—Air
- Air pressure at face.



The Cost of Mine Run Coal

This chart is intended to facilitate the work of adjusting different scale prices to a varying percentage of pick and screen coal.

The scope of this particular chart being to produce graphically the 1¼" and mine run price for any percentage of pick coal and from no per cent. to 50 per cent. of fine coal.

The method of reading will be understood by following the problem through.

PROBLEM — What should a miner be paid (cents per ton) mine run coal for 26 per cent. pick and 33 per cent. fine coal.

Pick rate $1.00 per ton. Machine coal. 69c per ton.

METHOD—Follow the course of heavy line beginning at 26 per cent. of pick coal. along the left hand border of sheet, to the diagonal line indicating the $1.00 pick rate, thence down to border scale marked 1¼" coal at face and read .77c cost per to at face .69c plus (.26x31) equals .7706c.

Thence along the converging lines to the intersection with line representing 33 per cent. of screening, thence up to the border scale and read 51.6c cost per ton at face for mine run coal.

.7706x(100-33) equals .7706x67 equals .516302 cents per ton, miners rate—$1.00 pick rate—26 per cent. pick mined coal, and 33 per cent. fine coal.

COMPILED BY DWIGHT GERBER SEPT. 1913
501 WABASH BLD'G PITTSBURGH, PA.

Coal Production for Various Seam Thicknesses

Short Tons

Density of Coal Assumed as 1.28, or
25 Cubic Feet per Ton of 2,000 Pounds

Height of Coal, Inches	Tons of Coal, per Acre	Tons per Square Foot Undercut	Depth of Undercut		
			5 Ft.	6 Ft.	7 Ft.
			Tons per Lineal Foot of Face		
24	3485	0.08	0.40	0.48	0.56
28	4070	.09	.47	.56	.65
32	4645	.11	.54	.64	.75
36	5225	.12	.60	.72	.84
40	5810	.133	.67	.80	.93
44	6390	.15	.73	.88	1.02
48	6970	.16	.80	.96	1.12
54	7840	.18	.90	1.08	1.26
60	8715	.20	1.00	1.20	1.40
66	9580	.22	1.10	1.32	1.54
72	10455	.24	1.20	1.44	1.68
78	11320	.26	1.30	1.56	1.82
84	12210	.28	1.40	1.68	1.96
90	13070	.30	1.50	1.80	2.10
96	13940	.32	1.60	1.92	2.24
100	14525	.333	1.67	2.00	2.33
104	15100	.347	1.73	2.08	2.42
108	15680	.36	1.80	2.16	2.52
112	16260	.373	1.87	2.24	2.61
116	16845	.387	1.93	2.32	2.70
120	17425	.40	2.00	2.40	2.80
126	18295	.42	2.10	2.52	2.94
132	19165	.44	2.20	2.64	3.08
138	20040	.46	2.30	2.76	3.22
144	20900	.48	2.40	2.88	3.36

THE JEFFREY MANUFACTURING COMPANY

Main Office and Works: 962 North Fourth St., Columbus, Ohio

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Middlesboro, Ky..Middlesboro Hotel
Charleston............West Virginia
Cleveland......421 Rockefeller Bldg.
Chicago............McCormick Bldg.
St. Louis...Railway Exchange Bldg.
Milwaukee............M. & M. Bldg.
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Seattle............L. C. Smith Bldg.
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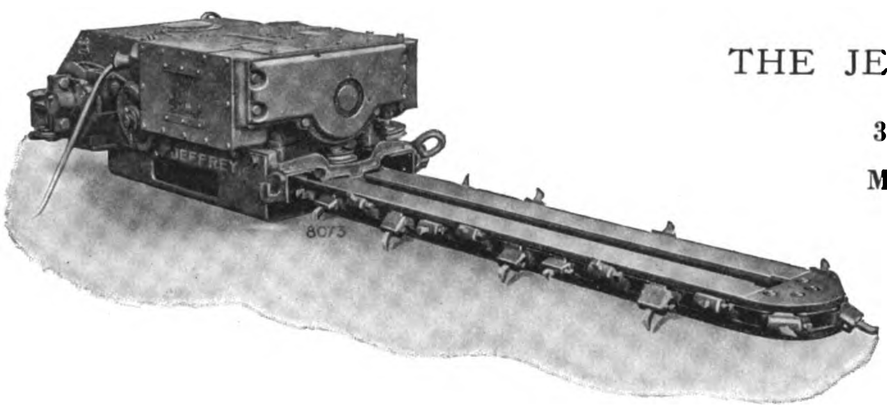
..Commonwealth Nat. Bank Bldg.
Canadian Works............Montreal

"Under-Cutting" Coal Mining Machines



THE JEFFREY 1917 MODEL

Trade Mark
35-B SHORTWALL
Reg. U. S. Pat. Office
MINING MACHINE

is the last word in Coal Cutter Design.

Special Features Incorporated In the 35-B Machine:

Narrow Cutter Bar and Narrow Base, enabling machine to follow rolling bottom.

Indestructable Machinery steel cutter-bar with renewable hardened liners.

Disc Clutches for controlling both Feed and Handling Drums—Give long life—Act as a Safety Device, as they will slip in case of undue strain on the ropes.

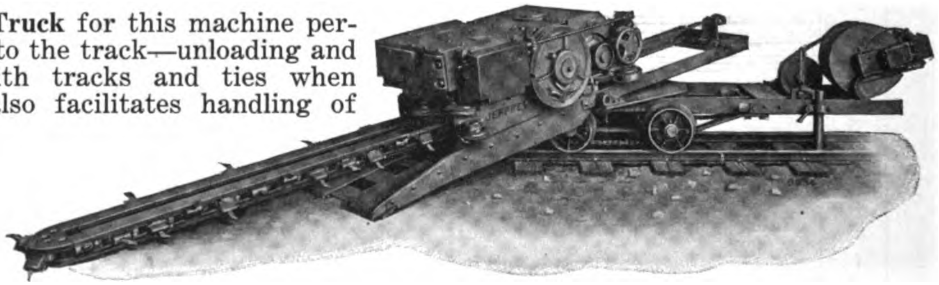
Independent operation of the Feed and Handling Rope Drums makes it possible to sump the machine in a small fraction of the time required by other machines.

Contains a less number of gears and parts than any other Shortwall Machine on the market.

Has powerful Motor Capacity. Starting Box of the controller type similar to locomotive controller.

The Self-Propelling Handi-Truck for this machine permits of unloading at any angle to the track—unloading and loading without interfering with tracks and ties when making break throughs, and also facilitates handling of the machine when the gob lies close or when the posts are set close to the face.

Send for Bulletin 192-62 on the Care and Operation of this machine.


Unloading 35-B Shortwall Coal Cutter From Self-Propelling Handi-Truck.

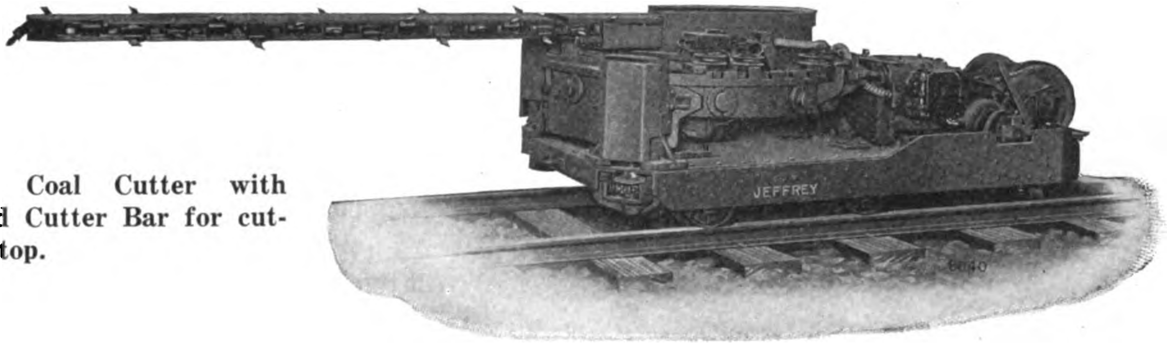
Jeffrey 21-A Breast Type Coal Cutter

Breast Type Mining Machines also furnished in types and sizes known to the mining trade as the 19-A and 16-D.

THE JEFFREY MANUFACTURING COMPANY

The Jeffrey "Arcwall" Coal Cutter

For "Overcutting System of Mining"



"Arcwall" Coal Cutter with **Straight Head** Cutter Bar for cutting **near the top.**

Special Features:

Self-Propelled and operates on track—no loading or unloading from trucks or tracks—cuts 100 to 200 per cent more coal than the unmounted machines.

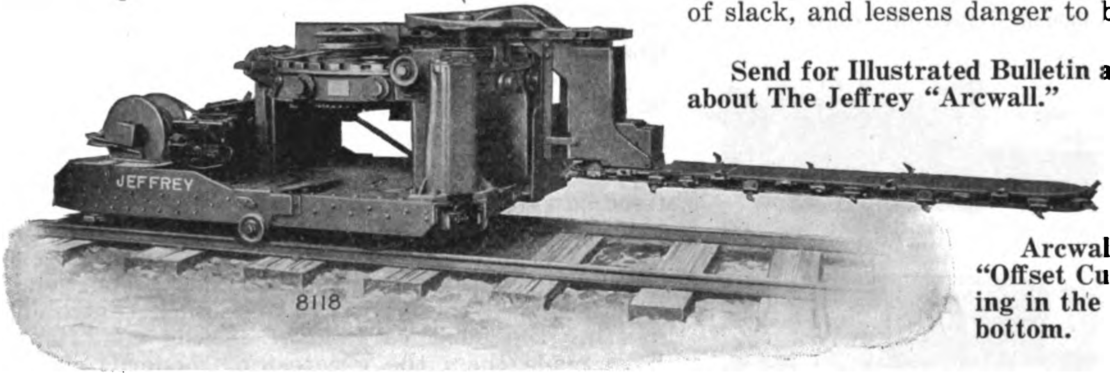
Average Cutting Record is 18 to 20 places in 10 hour shifts with 7 foot cutter-bar, having a 20 foot sweep.

Can be built to cut anywhere above the top of rail, mining in the coal or cutting out bone or binder.

Produces cleaner coal with less picking at the tipple, as dirt bands and dirt seams can be cut out and gobbed.

Undershooting requires less powder, makes a greater percentage of large coal and less percentage of slack, and lessens danger to bad roofs.

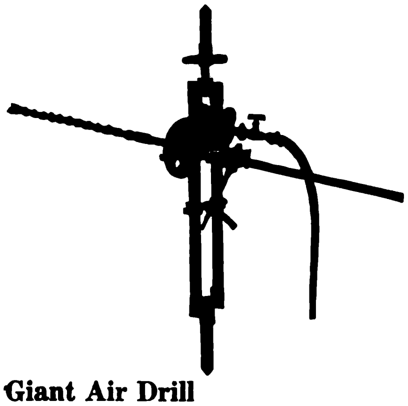
Send for Illustrated Bulletin **and full particulars** about The Jeffrey "Arcwall."



Arcwall **Coal Cutter with "Offset Cutter Bar" for Mining in the center or near the bottom.**

JEFFREY POWER DRILLS (Patented)

Made with either Electric, Air, Steam, or Hand Power.



Giant Air Drill

For use in gassy mines or when air power is the only power obtainable.

←

A-5-C Portable Power Drill

Ratchet device affords an easy adjustment. Easily set in place, and of ample motor power to drill through any material the auger-bit will stand up under.

A "one" man Portable Drill.

Write for Drill Bulletin.

Jeffrey Hand Drill

GOODMAN MANUFACTURING CO.

ELECTRIC MINING MACHINERY

General Office and Works: Chicago, Ill., Halsted Street at 48th Place.

BRANCH OFFICES AND REPRESENTATIVES:

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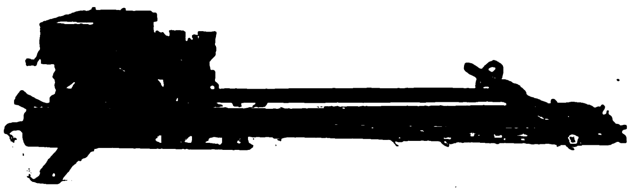
CHARLESTON, W. VA.—Union Bldg.

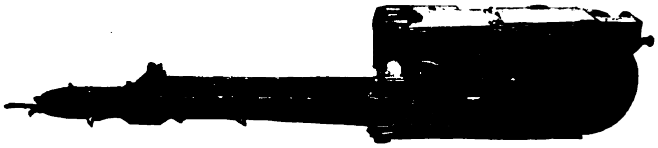
BIRMINGHAM, ALA.—Brown-Marx Bldg.
ST. LOUIS, MO.—Boatmen's Bank Bldg.
DENVER, COLO.—Boston Bldg.
SEATTLE, WASH.—512 First Ave., South.

AUSTRALASIA—Wm. Adams & Co., Sydney, N. S. W.

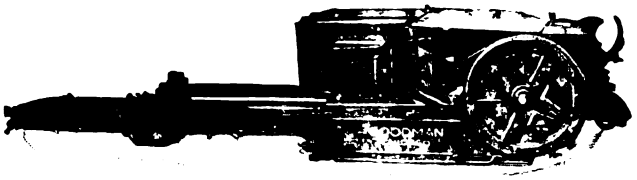
Standard Breast Machine, with Guarded Chain and Inclosed Electrical Parts.



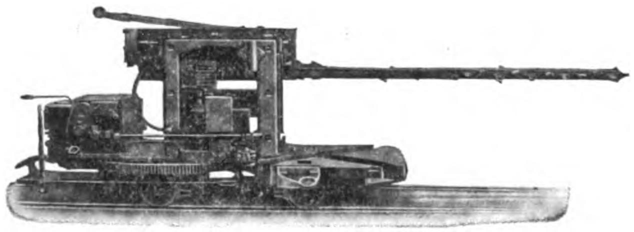
Standard Breast Machine, Alternating Current.



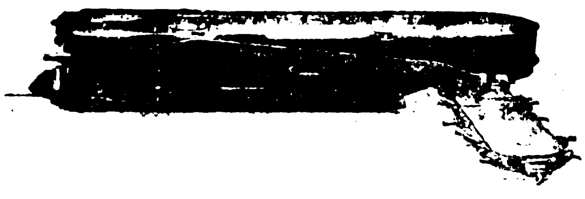
Shortwall Machine, Continuous Current.



Shortwall Machine, Alternating Current.



Straightface Centercutting or Overcutting Machine.



Longwall Machine for Continuous Faces.

The Goodman Line of Electric Coal Cutters provides a machine for every mining condition.

BREAST MACHINES
CENTER AND OVER-CUTTERS
SHORTWALL MACHINES
LONGWALL MACHINES

All types are made for operation by either continuous current or alternating current.

Electrical parts may be inclosed for operation in gassy mines.

Guarded cutter chains afford protection to men, and fulfill all legal requirements.

All parts of all machines are designed with generous proportions, for needed strength and durability.

Breast and Shortwall machines are moved on drop-front (patented) trucks, making loading and unloading easy, rapid and safe.

Goodman Breast Machines

Are of standard and low-vein types. They may be fitted for driving by compressed air instead of electricity, for service in gaseous mines, or where none but air power is available. Bulletin No. 104.

Goodman Shortwall Machines

Have won their way to unquestioned leadership in work to which this type of cutter is best suited. Their rugged construction and ample proportions, together with their positive and quick control in meeting the most variable of cutting conditions, have made them the greatest of modern mining machines. Bulletin No. 103.

Goodman Center and Overcutters

Are of two types—the Straightface machine and the Slabbing machine. Both work in position on the track and operate wholly by power. Bulletin No. 122.

The Straightface machine cuts a square place up to 20 feet wide, maintaining a straight face in a continuous swinging cut from side to side in entry or room. It is equally adapted to slabbing when desired.

The Slabbing machine swings its cutter arm in a circle, advancing entries and rooms in any widths up to 20 feet, and doing its wide work principally by slabbing off long faces, drawn along a parallel track by the feed rope to a jack set well back.

Goodman Longwall Machines

Are made either reversible or non-reversible and are equipped with tilting cutter arms to enable the operator to guide them over floor undulations or past obstructing impurities.

MORGAN-GARDNER ELECTRIC CO.

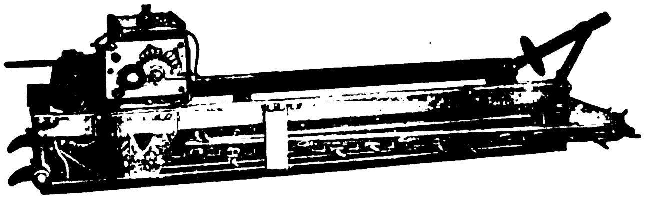
68 East Adams St., Chicago, Ill.

MINING MACHINES

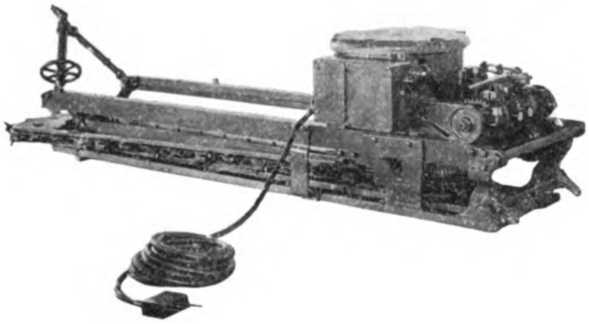
MINING MACHINES

CLASS OF MACHINE	HD	HHD	SS	SA D.C. CURRENT	SA A.C. CURRENT	TC
BREAST OR SHORTWALL MACHINE	BREAST	BREAST	BREAST	SHORT-WALL	SHORT-WALL	MOUNTED BREAST
COUMPOUND MOTOR	■	■	■	■	■	■
SEMI-ENCLOSED OR OPEN MOTOR	OPEN	OPEN	OPEN	SEMI-ENCLOSED	SEMI-ENCLOSED	SEMI-ENCLOSED
ENCLOSED CONTROLLER & ENCLOSED MOTOR FOR GAS	■	■		■		■
TOP BALL BEARING MOTOR	■	■		■		
FULL BALL BEARING MOTOR			■	■	■	■
HOUR RATING-BRAKE HORSE POWER	26	26	26	35	25	35
VOLTAGE-DC & 3P-60CY AC	250 500	250 500	250 500	250 500	220 440	250 500
GRID RESISTANCE	■	■	■	■		■
OPEN RHEOSTAT	■	■	■	■	ENCLOSED 3P SWITCH	
CYLINDER BLOWOUT CONTROLLER				■		■
½" FEED CUTTING ADAPTED TO	HARD	VERY HARD	HARD	VERY HARD	HARD	VERY HARD
⅝" FEED CUTTING ADAPTED TO	MEDIUM	HARD	MEDIUM	HARD	MEDIUM	HARD
¾" FEED CUTTING ADAPTED TO	SOFT	MEDIUM	SOFT	MEDIUM	SOFT	MEDIUM
1" FEED CUTTING ADAPTED TO	VERY SOFT	SOFT	VERY SOFT	SOFT	VERY SOFT	SOFT
DEPTH OF UNDERCUT-FEET	5' TO 10'	5' TO 10'	5¼ TO 10	4½ TO 10'	4½ TO 7½'	7' TO 10'
HEIGHT OF KERF-INCHES	4½"	4½"	4½"	4½"	4½"	4½"
WIDTH OF CUTTER ARM OVER BITS				20¾"	20¾"	
WIDTH OF CUTTER HEAD OVER BITS	45"	45"	45"			45"
HEIGHT OF MACHINE	31¾"	31¾"	19"	26⅞"	28¾"	MINIMUM 34" UP
OVERALL (SEE CUTTER HEAD) WIDTH OF MACHINE—	37"	37"	36"	34"	35"	WIDTH-TURNTABLE 60"
FOR 7 FT. MACHINE LENGTH OVER ALL	140⅝"	142⅝"	155"	127"	127"	173½"
LENGTH LESS CUTTER ARM				55"	55"	
HEIGHT ON STANDARD DROP AXLE TRUCK	37⅜"	37⅜"	NOT MADE	32½"	34⅜"	NOT MADE
HEIGHT ON STANDARD STRAIGHT AXLE TRUCK	40⅞"	40⅞"	31⅛"	35½"	37⅞"	MINIMUM 34"-UP
HEIGHT OF TURN TABLE MACH ABOVE RAIL TO TOP OF BITS	MIN 20¼"	MIN 20¼"	MIN 20"	MIN 23"		MIN 34"
TOTAL HEIGHT OF TURN TABLE MACHINE	MIN 44½"	MIN 44½"	MIN 31½"	MIN 44⅝"		MIN 34"
ADJUSTABLE IN HEIGHT	11"	11"	11"	NON ADJ		22"
MOUNTED MACHINE CUTS FROM TRUCK-NOT UNLOADED	■	■	■	■		■
STYLE CUTTING CHAIN	LIGHT	HEAVY	LIGHT	HEAVY	HEAVY	HEAVY
KEYSTONE BITS	■	■	■	■	■	■
RECTANGULAR BITS	½"x¾"	⅝"x⅞"	½"x¾"	⅝"x⅞"	⅝"x⅞"	⅝"x⅞"
SET SCREW	¾"x1¼"	¾"x1¼"	¾"x1¼"	¾"x1¼"	¾"x1¼"	¾"x1¼"
FOR 7 FT. MACHINE POSTS CAN BE SET FROM FACE	145"	145"	158"	58"	58"	96"
FOR GOOD ROOF	■	■	■	■	■	■
FOR BAD ROOF				■	■	■
FOR DANGEROUS ROOF				■	■	■
INDEPENDENT PROPELLING MOTOR						■
SELF PROPELLING MACHINE	■	■	■	■	■	
AUTOMATIC CABLE REEL	■	■	■	■	■	■
HAND WOUND CABLE REEL	■	■	■			
QUICK ACTING LEVER BRAKE	■	■	■	■	■	■

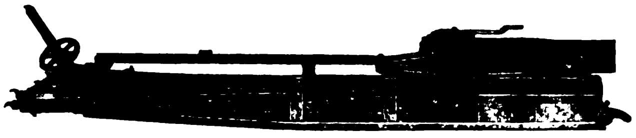
■ INDICATES, DESCRIPTION AT LEFT APPLIES TO HEADINGS



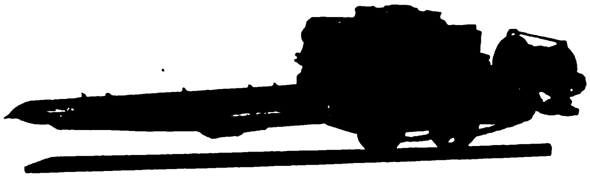
Type HHD, Breast Machine.



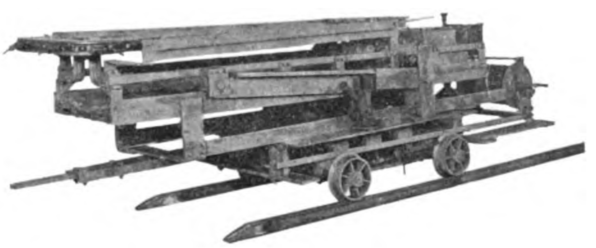
Type A, Breast Machine, A. C.



Type SS, Low Vein Breast Machine.



Type SA, Shortwall Machine.



Overcutting Mounted Machine.

The Morgan-Gardner Equipment has met with splendid success in widely separated mining fields—Of all these thousands of mining machines in operation nothing could better establish their ability to stand up under the hardest usage than the fact that many of the earliest machines are still in daily service. Always on the job—Low maintenance costs—Convenient operation—make them popular.

We have a machine for cutting under any condition of mining.

Let us co-operate in equipping your property.

SULLIVAN MACHINERY COMPANY

General Offices, 122 So. Michigan Ave., Chicago, U. S. A. Works: Chicago; Claremont, N. H.

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DENVER
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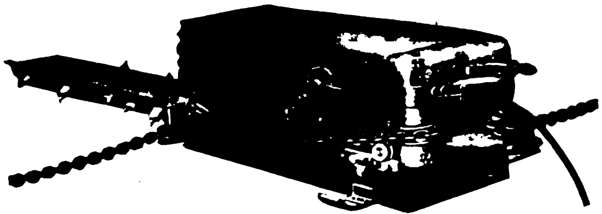
NEW YORK
PARIS
PITTSBURGH
SCRATON
ST. LOUIS
SALT LAKE
SPOKANE
SYDNEY
VANCOUVER
PETROGRAD

"Ironclad" Coal Cutters, Electric or Air

IRONCLAD SUMMARY

Types

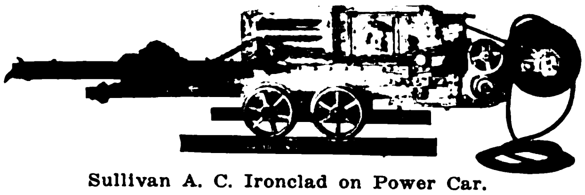
1. Room and Pillar, on the continuous cutting plan, originated and patented by this firm.
2. Longwall.
3. Mounted machines for over cutting.



Sullivan Explosion-Proof Ironclad.

Drive

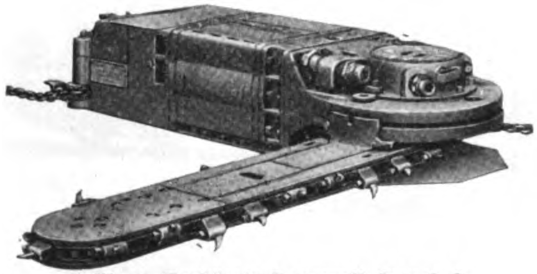
Electric Motors, D.C. or A.C. or "Turbinair" spiro turbine air engines. All 30 H. P.. All motor sections interchangeable.



Sullivan A. C. Ironclad on Power Car.

Feed

Chain drive from friction-protected feed gearing; safe, reliable, economical and convenient.



Sullivan Turbinair Longwall Ironclad.

Undercut

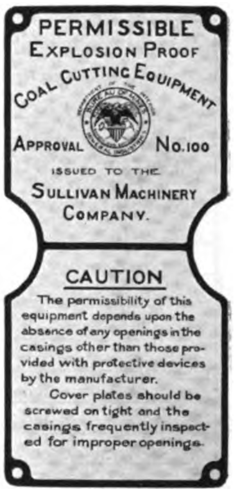
Cutter bars available for use in rooms up to 10 ft. 4 in. long; for longwall faces, from 24 to 66 in. Kerfs 5 to 5¾ in. high.

Handling

All handling, loading and moving is by the power of the "Ironclad" itself.

Safety

Interlocking friction and feed levers prevent injury to machine. U. S. Government-approved explosion proof motors and reels are available for gassy workings. Armorplate housing protects runner from moving parts or shock.



PERMISSIBLE
EXPLOSION PROOF
COAL CUTTING EQUIPMENT
APPROVAL No. 100
ISSUED TO THE
SULLIVAN MACHINERY
COMPANY.

CAUTION

The permissibility of this equipment depends upon the absence of any openings in the casings other than those provided with protective devices by the manufacturer.

Cover plates should be screwed on tight and the casings frequently inspected for improper openings.

Adaptability

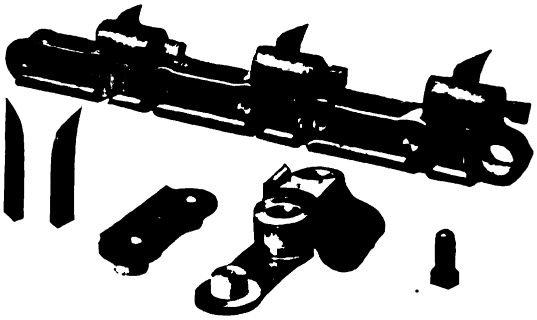
Room and Pillar Ironclads are reversible, cutting the face either way as desired. Chain drive permits cutting out impurities or handling irregular face or bottom.

Compactness

Room Ironclad is 23 in. high when cutting, 70 in. long with bar under coal. Longwall machine is 17 in. high and passes inside props set 36 in. from the face.

Trucks

Room and Pillar Ironclads have power trucks with self-winding reels, friction drive and brake and runner's platform.



Sullivan Superdreadnaught Cutter Chain.

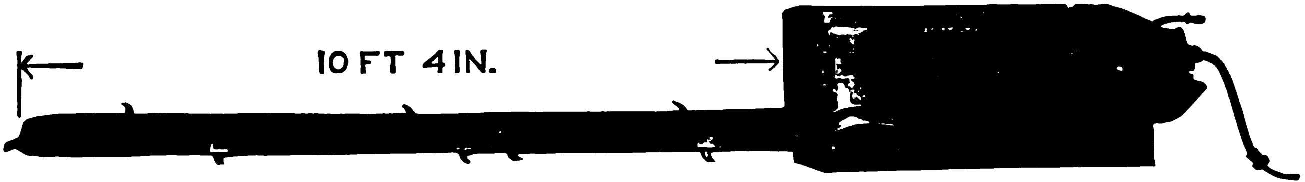
Cutter Chains and Bars

All wearing surfaces of Ironclad cutter chains are hardened. The links are interlocking and ribbed and are reversible. Superdreadnaught chains have nine cutter positions. The chain runs in closely gibbed guides. Roller bearing cutter heads and built up cutter bars give maximum power and repair economy.

Sullivan Turbinair Rotor.

Full Description of all Types

Ask for Bulletin 73-ED, Sullivan Pick Machines; Bulletin 73-FD, Sullivan Post Punchers; Bulletin 57-AD.



A "Long Bar" Sullivan Ironclad, for deep mining.

BERTRAND P. TRACY

32nd Street and Penn Avenue, Pittsburgh, Pa

Manufacturer and Dealer In

Repair Parts for Coal Cutting Machines and Mine Locomotives

Supplies and Materials for Electrically Operated Coal Mines

PRODUCTS

For Machines

Shafts, Gears, Pinions,
Worms and Worm Gears,
Bronze and Graphite Bushings,
Cutter Heads, Chain Guides,
Brackets, Sprockets, Clutches
Commutators, Rheostats,
Chain Set Screws,
Studs, Screws, Bolts and Nuts,
Bits and Bit Steel,
Lifting Jacks, Oilers, Shovels,
Wrenches, Carbon Brushes,
Electric Cable, Steel Cable,
Winch Rope, Etc.

For Locomotives

Steel Tires, Steel Gears,
Armature Pinions (Oil Tempered),
Armature Shafts,
Armature Shaft Bearings,
Axles,
Axle Bearings,
Commutators,
Carbon Brushes,
Trolley Wheels, Poles and Harps,
Arc Head-lights.

For the Repair Shop

Armature Coils,
Commutators,
Insulating Materials,
Mica and Mica Products
Asbestos Materials,
Insulating Tape—All kinds,
Sleeving, Twine,
Insulating Varnish, Shellac,
Babbitt Metal, Solder, Salts
Hard Fibre,
Shop Tools of every kind.

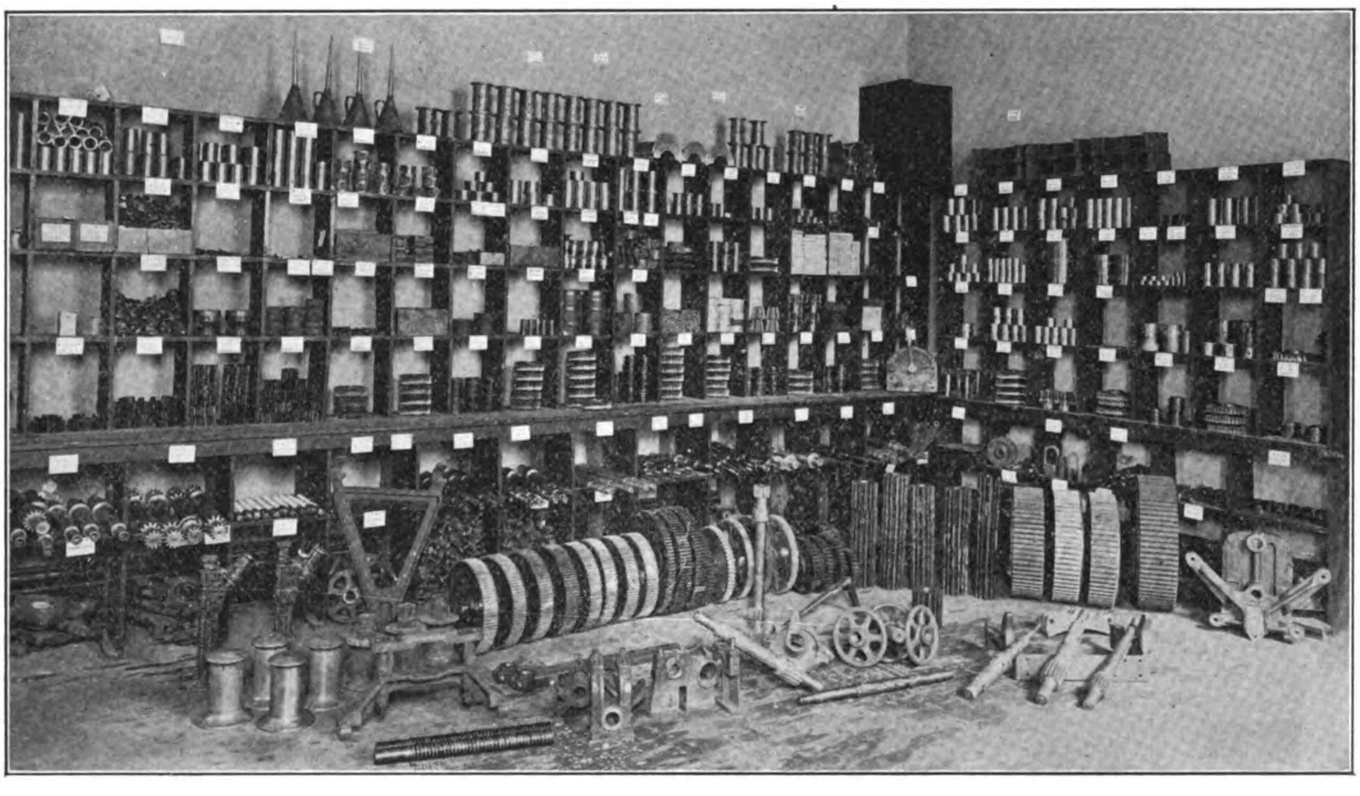
Sundries

Ammeters, Voltmeters,
Starters, Rheostats,
Circuit Breakers,
Switches, Magnetos,
Fault Finders,
Lighting Supplies,
Line Material,
Rail Drills.

SERVICE

"The Paramount Consideration"

Our knowledge of requirements, facilities and location enable us to guarantee a service that is correct in every detail. Correspondence solicited. Catalog on request.



A corner in our stock room showing a portion of over 4,000 items, we carry in stock, insuring prompt deliveries.

Buettner & Shelburne Machine Company, Inc.

TERRE HAUTE, INDIANA

Manufacturers of

Repair Parts for Coal Mining Machines

Products

Cutter Heads, Cutter Chains, Blocks, Side Straps, Bit Set Screws, Chain Guides, Shafting, Bushings, Gears, Drive Sprockets, Rheostats, Series Coils, Field Coils, Commutators, Armature Rewinding, etc.

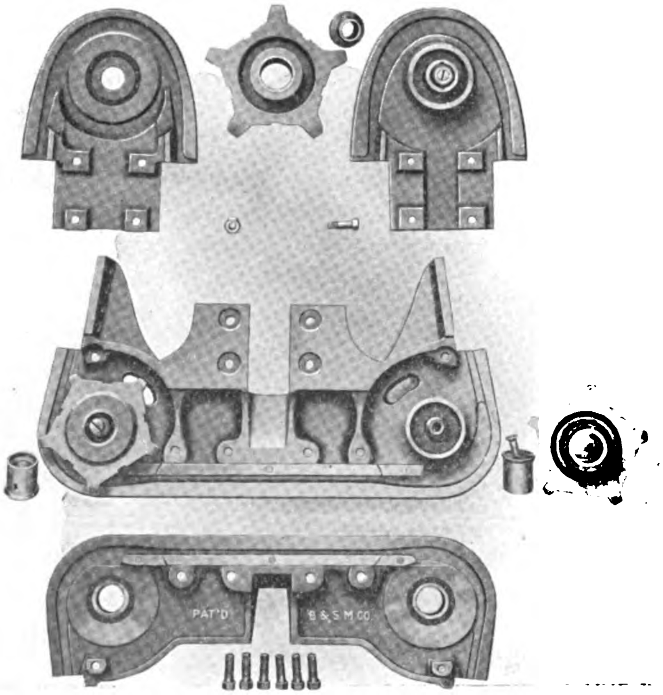
Use Cutter Heads That Insure Longer Service

Friction—the destroyer of efficiency in machines otherwise mechanically perfect—lurks and "works" in the bearing seats of your cutter head Idler Sprockets. It eats up power. Boosts maintenance costs. Save these unnecessary losses and enjoy smaller bills for repairs by using well-built, simple, durable

B. & S. Improved Cutter Heads.

Wear at the vital points—at the bearing seats of the idler sprockets that carry the endless cutter chain—is practically eliminated. There's no lost motion for the Idler Sprockets to perform—no unnecessary work—for the bearings are completely enclosed—isolated. This enables the wheels to always run in oil and allows

Perfect Lubrication.



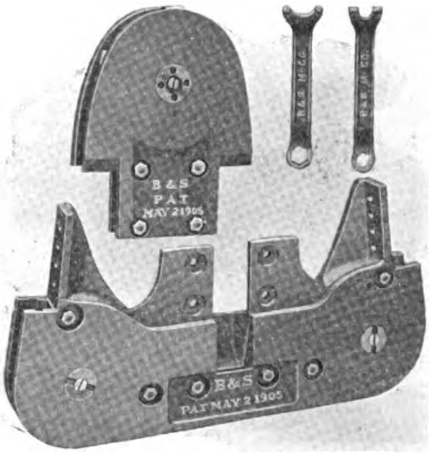
Longer life of the parts is made certain. The oil cell in the bearing seats of the Idler Sprockets in B. & S. Cutter Heads is a special feature which warrants your further thorough investigation. No dust, grit or dirt can possibly work into the oil cell for the top half of the cutter head is fastened down tightly on a felt washer used for a gasket over the Idler Sprockets and the shoulder on the Idler Sprocket stud.

Space Between Upper and Lower Half of Cutter Head Not Entirely Filled

The tool-steel cutter head Wearing Bars are so made that they will not entirely fill the space between the upper and lower castings of the cutter head.

Expansion—caused by use of the machine—is thus allowed for, since irregularities and burrs are always produced by the endless cutter chain traveling over the surface and edges. These irregularities ordinarily cause the top half of the cutter head to rise, letting dust and grit into the oil cells of the Idler Sprockets. But not so in a B. & S. The cutter head can't rise! No dirt can enter!

Space here will not allow us to go deeply into detail but if you will just write and request further information we shall very gladly and promptly reply and tell how you can clinch a very worth-while saving by using long-service B. & S. Improved Cutter Heads. Built for all types and makes of machines.



Wear on B. & S. Cutter Chains is equalized—not centralized. It occurs evenly at all points. Is always evenly distributed in both Chain Block holes and both Side Strap bosses. Longer life is certain under the hardest work you can possibly impose.

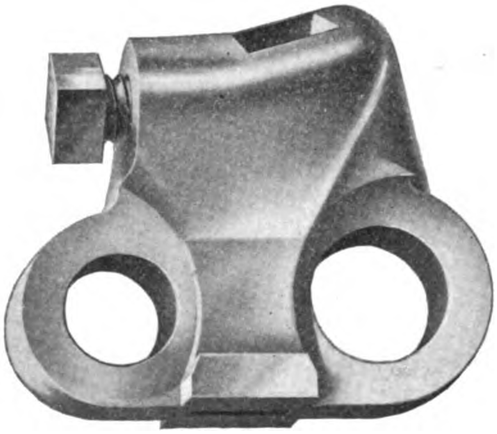
Save the Loss from Short-life Cutter Chains

Check over the number of times "junking" only half worn cutter chains became necessary, and you will immediately realize the great saving possible by using tough, double-life "B & S." Chains that equalize wear instead of centralizing it. Mine operators everywhere recognize them as small but indispensable factors in keeping down up-keep expense and preventing stripped chain guides, besides preventing many other serious costly damages to machines.

"B. & S." Improved Cutter Chains

Wear is evenly distributed—instead of coming first and fast on the rear hole of the chain block and the front boss of the side strap. Common type cutter chains wear there first because those sections receive the greatest amount of friction when the drive sprocket teeth force the chain forward.

This even distribution of wear on "B. & S." Cutter Chains is secured by increasing the diameter of the rear hole of the chain block and front boss of the side strap—therby increasing the amount of frictional surface.



Longer Service Without Added Strength

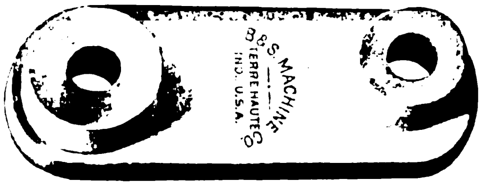
Since the front hole of the chain block and the rear boss of the side strap are the same size as those of ordinary, standard chains, the ultimate pulling strength of the "B. & S." Chain is not increased. The usual safety to the machine's drive gears is thus insured, for the rear boss will shear when the resistance becomes excessive.

Even Distribution of Cutting

By using seven-position cutter bits or blocks even distribution of the cutting of each bit is certain—strain on the machine is greatly reduced—and 5 to 10 amperes in power are saved.

Next Time You Discard a Cutter Chain

—examine the worn places. Note where they are. Then you will be surer than ever that the "B. & S." gives longer continuous service than you ever thought possible. Moreover, you will know then that the wear on the discarded chain shortened its life to half that of a "B. & S." on which wear is equalized—not centralized. Write us now for further information, facts and figures showing how quickly the "B. & S." Improved Cutter Chain will save its cost when once put to work on your machine. Just address Buettner & Shelburne Machine Company, Inc., Terre Haute, Indiana.



B. & S. Improved
Cutter Chain

FRANK PROX COMPANY

TERRE HAUTE, IND.

"Everlasting Line"

Cutter Heads, Chains, Guides, Gibs, Etc.

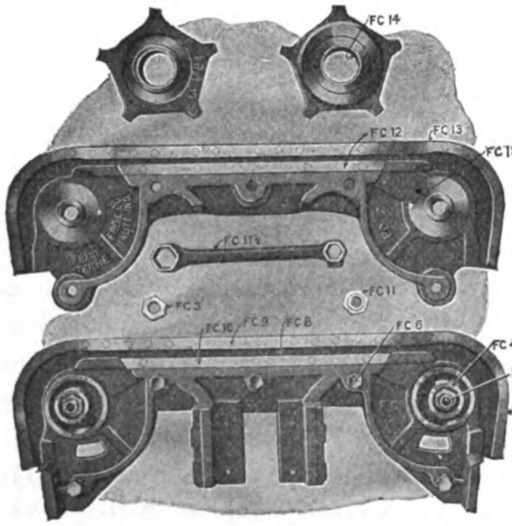
For All Makes of Breast, Short and Long Wall Mining Machines.

Mr. Purchaser and General Manager:

Have you stopped to consider, when you throw away a cutter head, that not more than 3 per cent of its material has been worn away? But its vital features have been destroyed and the head has been rendered useless. This is not the case with our cutter head. When the parts carrying the chain have been worn away they can be replaced with new wearing strips which are drilled to fit the holes in the head exactly. It is only necessary to punch out the rivets and rivet on the new strips, which can be done by any blacksmith or mine electrician. The chain guiding elements are again renewed and the head is as good as new.

With a plant of 15 machines using a cutter head every 18 months this part of the machine would cost $483.00 per year, not considering extra parts for repairs such as front bearings, sprockets and bushings. With a full equipment of our heads we could furnish the complete set of renewable wearing surface strips for about $12.00 per set, thus effecting a saving of $303.00 per year.

Our sprockets and bearings are also more durable than any other make on account of being made of superior material and provided with a perfect system of lubrication. The front stud, when worn on one side, can be turned around and worn on the opposite side, thus doubling its life. The first head will be sent on thirty days' approval.



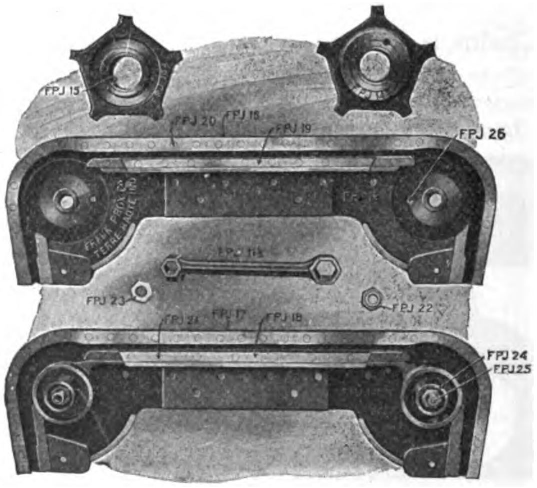
Prox Improved Cutter Head for H. D. & H. H. D. Morgan Gardner Machines.

Type F. C. 1-2 36" Cutter Head H. D. Center to Center of Sprockets 26½.

Type F. C. 3½-4½ 38 Cutter Head H. D. Center to Center of Sprockets 28".

Type F. C. 81-82 32" Cutter Head H. D. Center to Center of Sprockets 23".

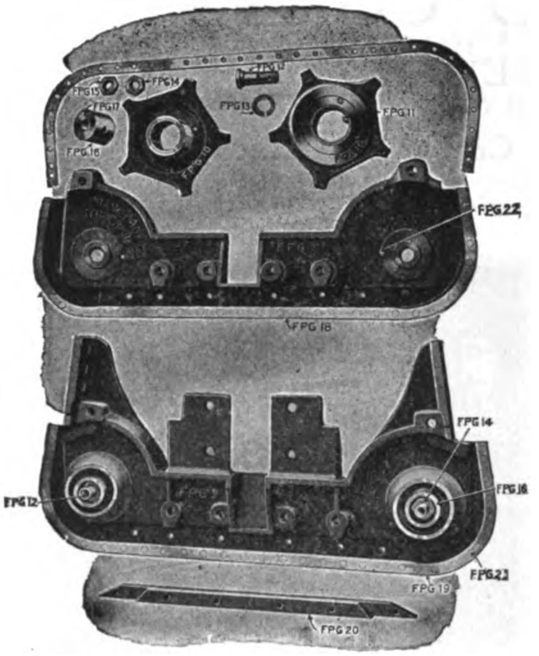
Type F. C. 65-66 39" Cutter Head H. H. D. Center to Center of Sprockets 27¾".



Prox Improved Cutter Head for "Jeffrey" Machines.

F. P. J. 13-14-19A 44 Cut No. 7 Chain.
F. P. J. 29-30-17A 44 Cut No. 7 Chain.
F. P. J. 31-32-17A 44 Cut No. 8 Chain.
F. P. J. 33-34-19A 39 Cut No. 7 Chain.

Send for Savings Account Booklet.



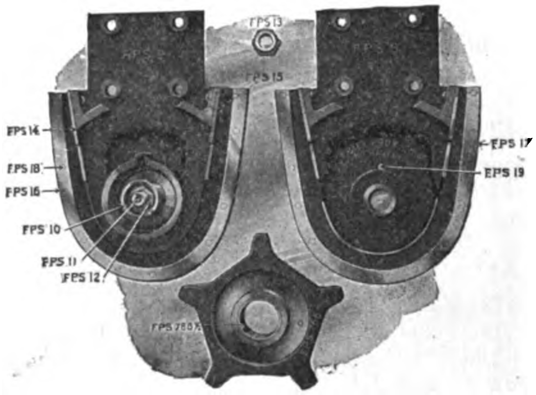
Prox Improved Cutter Head for Goodman Machines.

Type F. P. G. 1-2 42" Cut No. 7 and 10 Chain.
Center to Center of Sprocket 26".

Type F. P. G. 3-4 44" Cut No. 7 and 10 Chain.
Center to Center of Sprocket 28".

Type F. P. G. 57-58 42" Cut No. 11 Chain.
Center to Center of Sprocket 26¾".

Type F. P. G. 55-56 45" Cut No. 11 Chain.
Center to Center of Sprocket 29¾".



Prox Improved Cutter Head for "Sullivan" Type C. E. Machine.

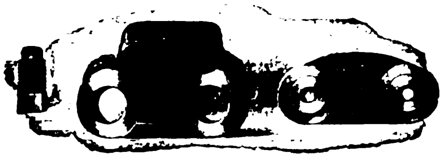
Prox Chain for use on Sullivan Machine 7 Position Type C. E. Reinforced. Hardened Wearing Surfaces.

Made Extra Strong.
5 Foot Under Cut 28 Block.
6 Foot Under Cut 33 Block.

Chain for use on Morgan-Gardner Machine, Type H. D. Reinforced. Hardened Wearing Surfaces.

"Heavy Duty" Chains to do the work must be strong. We have added to the metal of the block and side strap of this chain where needed. The operator using them never had a kick.

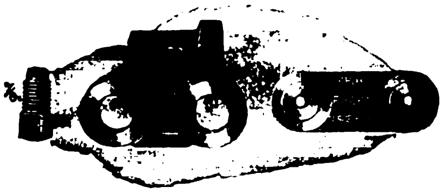
Made for H. D., H. H. D. and Short Wall Machines, Square and Keystone Bits.



Prox Chain for use on Jeffrey Machine Nos. 17 and 19A, Type 7. Reinforced. Hardened Wearing Surfaces.

This Chain is made up with the greatest care and out of the best material. The block has been reinforced (see cut) and the side strap is our trussed pattern. You can't beat it.

Made in No. 7B, No. 7C, No. 8 and Short Wall Machine.



Chains for use on Goodman Machines for Type E. Reinforced. Hardened Wearing Surfaces.

This Chain, like the others we turn out, has had special attention of our engineers and has been built up until it has now reached a degree of perfection that we never have complaints on it. Every user is a booster.

Goodman No. 7 and 10 Chain.
Goodman No. 11 Chain.
Goodman No. 12 Chain.
Goodman "Shortwall."

Guides and Gibs

We make Chain Guides for H. D. and H. H. D. Morgan-Gardner and Goodman make of machines with hardened removable wearing surfaces, and Extra Heavy Gibs for Sullivan short wall machines with hardened steel wearing surfaces. The kind that won't open up.

INGERSOLL-RAND COMPANY

11 BROADWAY NEW YORK

Manufacturers of Compressed Air Coal Mining Machinery

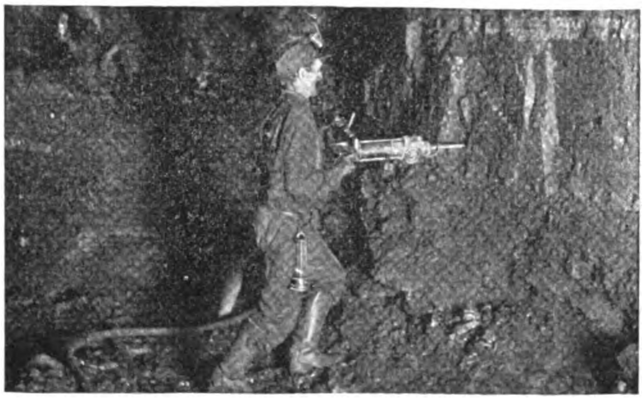
"Jackhamer"

A fast drilling, easily handled, hammer drill. It has a strong, positive, automatic rotation and when used with twisted steel is a superior tool for boring coal.

Fitted with hexagon steel the "Jackhamer" is a rock drill that has almost universal application. It can be used for any of the rock drilling jobs around the mine from shaft sinking and driving gangway to ditching, cutting hitches, etc.

It can be slipped into a feed shell mounting when desired and can also be had with the Leyner Water Device.

Bulletin 4221.



"Radialaxe" Coal Cutter

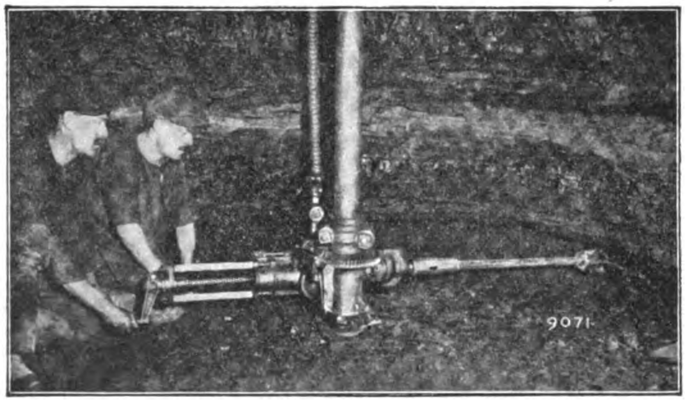
For undercutting in a pitching seam, overcutting, shearing, driving entries and cutting out clay bands the Radialaxe will work faster, at less cost and with greater certainty than any other means.

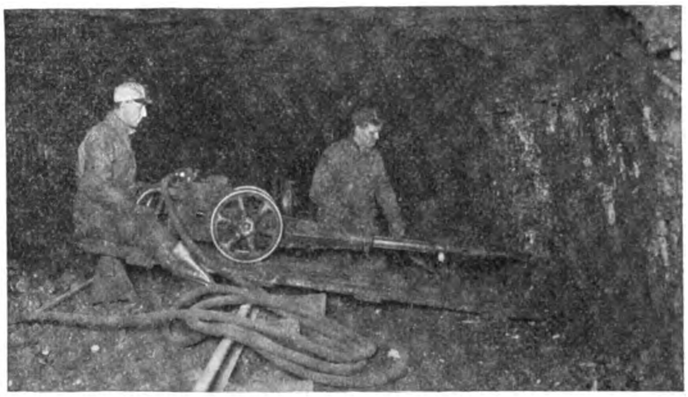
It is an air driven machine which will make a long deep cut in the coal face, at any angle from horizontal to vertical.

You can also use it for regular rock drilling.

The "Radialaxe" is a valuable addition to the equipment of every up-to-date coal mine.

Bulletin 5006.





"New Ingersoll" Coal Puncher

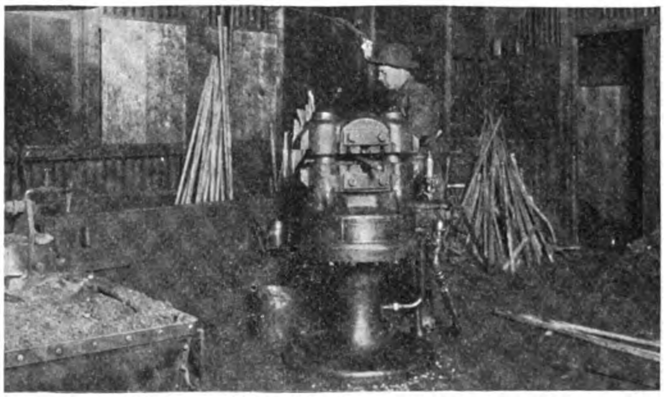
An all around puncher, adopted to hard or soft coal, thick or thin seams, high or low pressure.

It strikes hard, costs less for repairs, is correctly balanced and practically vibrationless. Its reliability insures full tonnage every day.

It is a safe machine—it cannot "race" nor is there any deadly recoil. An automatic throttle cuts off the air when the pick misses and opens up again when cutting begins.

The "New Ingersoll" puncher is "The Pick without a Kick."

Bulletin 5003.



Leyner Sharpener

An air operated machine for forging and resharpening drill bits and chain cutter bits, and forming drill shanks of all kinds, bolts, coupling pins, etc.

It is compact and safe and is the most efficient means of doing such work.

A single lever controls all operations. All work is done in the machine.

Bits made in the Leyner Sharpener are correctly formed and guaged, cut faster, remain sharp longer, and can be produced at a fraction of the cost of hand labor.

Bulletin 4122.

The Pneumelectric Machine Company

SYRACUSE, N.Y.

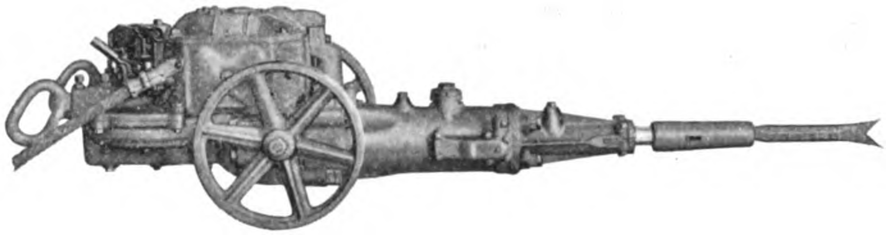
Pneumelectric
TRADE MARK

Electric Coal Puncher

Coal Puncher

An electrically operated self contained coal cutter of the puncher type in which the blow is struck by compressed air, the air being compressed and utilized in the same cylinder at each stroke of the machine. The power consumption is but 6 kilowatts at the machine when in operation.

The machine consists of the motor, gear case, and cylinder, all combined into one complete compact unit of small dimensions and light weight.



There are two pistons in the cylinder. One is driven by the motor, the other carries the cutting tool and is acted upon by the compressed air. The blow is powerful, effective, and capable of dislodging more coal with less power consumption than any other machine of the puncher type, in addition to which all the advantages of electrical transmission of power are available.

Uses and Advantages

The Pneumelectric Puncher being light, easily handled, and a fast cutter, is especially applicable to heading driving, narrow rooms, rolly bottoms, pillars or other places where it is necessary to timber close to the face. It is used very advantageously in conjunction with machines of other types, as in such cases each machine is applied to the conditions to which it is particularly adapted and the most economical results are secured.

Specifications and Equipment

Pneumelectric Punchers can be furnished with motors wound for the standard mine voltages of direct current or for 2 or 3 phase, 60 cycle, alternating current power. Each machine requires cable, reel, tools, picks, running board, truck, trestles, etc., all of which may be included with the machine, furnished separately, or omitted, as conditions may require.

Installation and Expert Reports

Pneumelectric Punchers are being operated under all conditions of mining. Where the conditions are such that there is any question regarding the applicability of the machine, we are prepared to make examinations and report as to the advisability of using this machine for all or any part of the work. Our men are experienced in machine mining and their reports are reliable.

FAIRMONT MINING MACHINERY CO.

Regular Equipment.
Tipple Structures
Screens and Chutes
Loading Booms
Picking Tables
Conveyors—all types
Cable Car Hauls
Chain Car Hauls

General Offices and Works
FAIRMONT, W. VA.

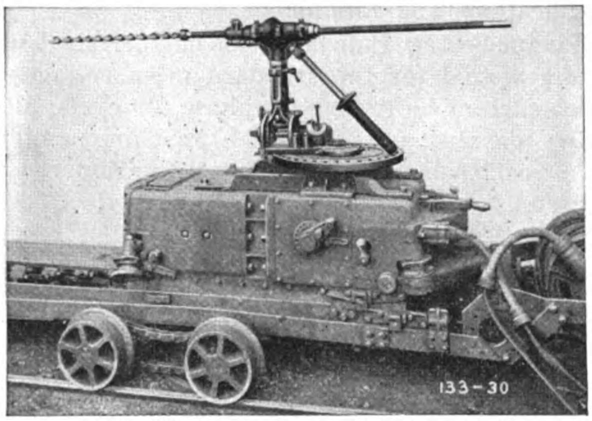
TRADE MARK REGISTERED
FAIRMONT
(The Mark of Quality)

Specialties
Steel Mine Ties
R. R. Car Retarders
Portable—
Electric Mine Pumps
Power Coal Augers
Box Car Loaders
Mine Car Trucks

COAL MINE EQUIPMENTS

Fairmont Power Auger

The Fairmont Power Coal Auger is a machine for mounting on any standard make of chain undercutting machine, with which the machine runner does the drilling of the coal.



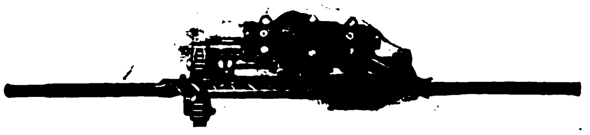
Coal Auger in operation.

Operation

The power for operating the machine is furnished by the mining machine motor through a chain or gear drive, depending on the type of mining machine. The time required for drilling a 7-foot hole is about one minute, so that the time taken from the operation of the mining machine is very small.

Economy

When the machine runner does the drilling and a regular shot firer is employed in the mine to do the shooting, cheaper labor can be employed to do the loading.



Showing how Auger lays flat on Machine for moving from room to room.

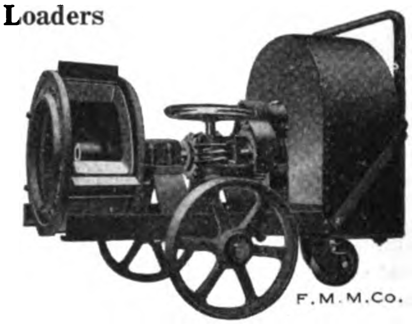
Flexibility

Owing to the flexibility of the auger, the holes can be properly placed at any height and angle for the best results, and it has been demonstrated that more coal is produced at every cut when the machine runner does his own drilling with the Fairmont Auger.

The Fairmont Auger has been in successful operation for more than ten years. They are in successful operation on Jeffrey, Morgan-Gardner, Goodman and Sullivan machines, and we will gladly send you a machine with a man to demonstrate it, at any time.

Fairmont Box Car Loaders

The Fairmont Box Car Loader is of the rotary type and consists essentially of an impeller which revolves within a cylindrical casing having a side opening for the discharge of the coal, and either the front or back end open for the loading chute.



18-inch S Loader.

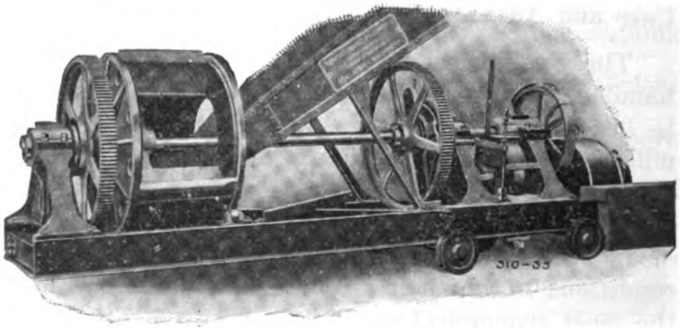
Construction

The casing is mounted on a hollow shaft through which runs the drive shaft from the motor to the impeller. The hollow shaft is adjustable, by hand or power, to regulate the position of the discharge orifice to properly place the coal in the car. At the same time it furnishes (with the addition of two bronze bushings), the main bearing and an oil reservoir for the drive shaft. A fibre washer placed between the casing and the hub of the impeller prevents dust and dirt entering the bearing, and prevents loss of oil.

The impeller is made of a single casting and will withstand years of ordinary wear. The casing wall is the part most subject to wear by contact with the coal, and consists of a steel plate bent to the proper curvature. It is clamped between the heads of the casing by bolts and is easily renewed. With ordinary usage these plates will last for two years or more, with constant use.

Drive, Sizes and Capacities

Fairmont Box Car Loaders can be equipped for direct connected motor or steam engine drive, or geared motor drive. They are built in sizes with 18-, 30- and 48-inch impellers, capable of loading from 40 to 150 tons per hour.



48" Electric Loader furnished North Western Fuel Co.

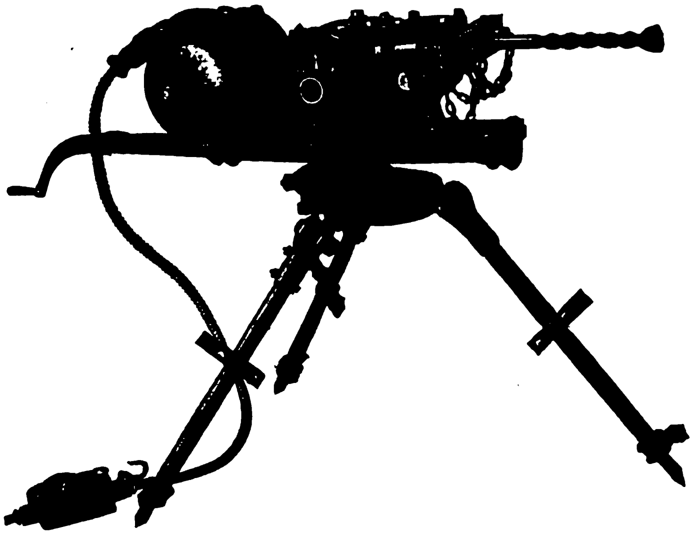
GENERAL ELECTRIC COMPANY

Fort Wayne Dept.
Fort Wayne, Ind.

The Guarantee of Excellence on Goods Electrical

Sales Offices
In All Large Cities

Electrical Supplies for Mines---Rock Drills



Fort Wayne Electric Rock Drill.

The Electric Rock Drill

One of the principle advantages of the Fort Wayne rock drill is the fact that thin veins of coal lying between hard rock, can now be mined at a profit. Fort Wayne electric rock drills are making such mining operations profitable in some of the largest coal properties in this country. The drills can be quickly set out of the way where they will not interfere with haulage and other mining operations.

The drills are also used for shaft sinking, brushing, passing through faults, upraising, overcasting and rock entry work. They do not require experienced labor to operate them.

The Fort Wayne electric rock drill is of the rotary hammer design. The mechanism of the drill proper consists of two parts: the revolving helve containing two hammers, and the chuck mechanism which holds and rotates the drill steel as it receives the blows from the hammers. When operating at normal speed, the drill steel receives 1700 hammer blows per minute and since the drill steel is rotated, every hammer blow has maximum cutting effect. The auger shape of the drill steel automatically elevates the cuttings from the hole no matter in what direction the hole may be drilled.

The drill can be mounted on tripod, column, shaft bar, gadder post or quarry bar. Our tripods and columns are particularly designed for this drill, but mountings can be furnished that will adapt the drill to use on other makes of tripods or drill columns.

The drill is operated by a special fully enclosed splash proof electric motor. Motors can be furnished for use on practically any system of distribution, except single-phase. All motors are designed for the same mounting on the drill so that an alternating current motor may be instantly substituted for a direct current motor and vice versa.

Two men can easily handle this rock drill. It will put in holes up to 12 feet in depth, finishing 1⅜ inch diameter. In some classes of work, holes of even greater depth than 12 feet can be driven.

Bulletin No. 1143, giving complete data will be sent on request.

Established 1878

Howells Mining Drill Co.

H S TRADE MARK "REG. U.S. PAT. OFF."

Main Office and Works:

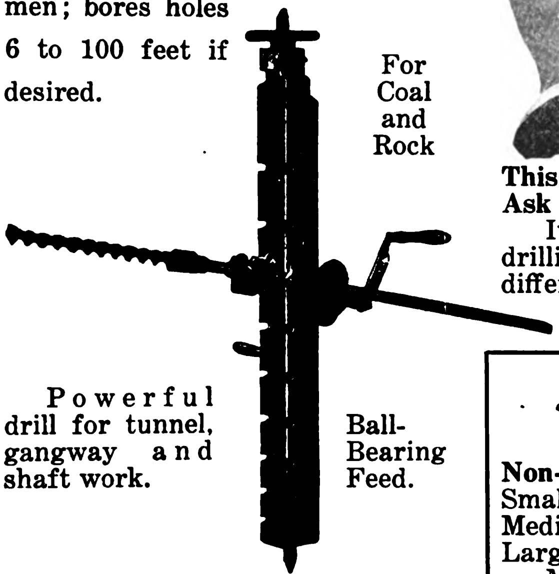
PLYMOUTH, PA., U. S. A.

Manufacturers of **Mining Machines** Of Every Known Description

Operated by Hand, Compressed Air or Electricity

Heavy Geared Post Drill

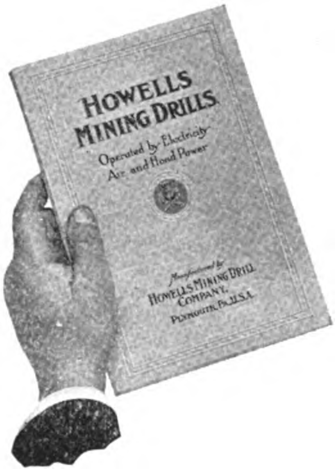
The strongest ball-bearing hand-power drill manufactured. Bores all kinds of coal, slate, shale, medium rock, sulphur, etc.; post easily adjusted; steel feed bar; also made with driving bar and ratchet; gearing to withstand the strength of two or four men; bores holes 6 to 100 feet if desired.



For Coal and Rock

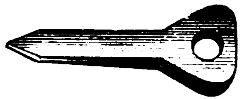
Powerful drill for tunnel, gangway and shaft work.

Ball-Bearing Feed.


HOWELLS MINING DRILLS
Operated by Electricity Air and Hand Power
Manufactured by Howells Mining Drill Company, Plymouth, Pa. U.S.A.

This Book Is Free
Ask For It

It's easy to solve the drilling problem from 40 different types of drills.



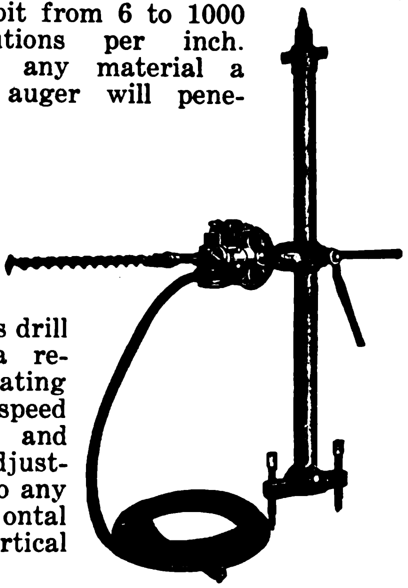
Non-Corrosive Spads

Small size.....1⅜" long.
Medium size...1¾" long.
Large size.......2" long.

Made of Brass, Copper or Steel.

Compressed Air Drill

With 60 pounds pressure, bores coal 6 feet per minute; rock 2 to 3 feet; can be operated in any position; suitable for post or cross-bar; automatic feed device which advances the drill bit from 6 to 1000 revolutions per inch. Bores any material a steel auger will penetrate.



This drill has a reciprocating high-speed motor and is adjustable to any horizontal or vertical angle.

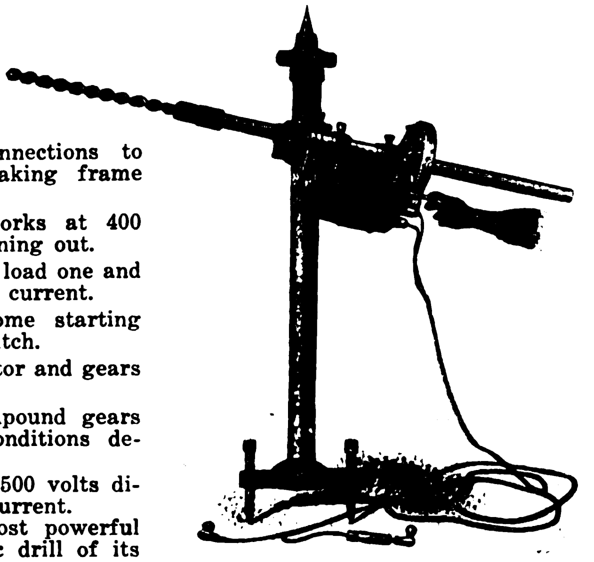
Spry Electric Drill

Points of Advantage

1. Motor carries 300% overload for short intervals and 500% momentarily.
2. No wire connections to look after when taking frame apart.
3. Armature works at 400 degrees without burning out.
4. Starts at full load one and a half times normal current.
5. No cumbersome starting box, but internal switch.
6. Weight of motor and gears 115 lbs.
7. Back or compound gears furnished where conditions demand.

Built for 110 to 500 volts direct or alternating current.

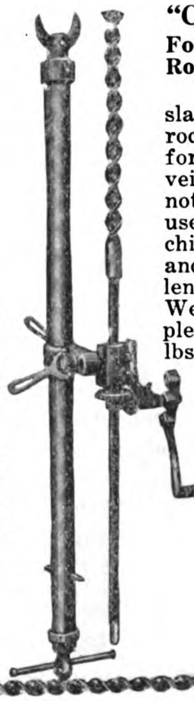
The simplest, most powerful and compact electric drill of its type.



Spry Type

For Electric Haulage

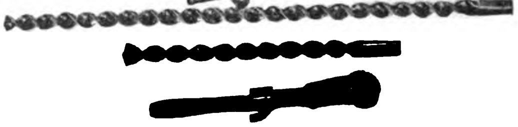
Machine in position for boring vertical holes. Will be found invaluable in connection with installation of electric haulage for drilling holes in roof and rib for insulator pegs. Built to operate at any angle.



"C" Machine

For Coal and Rock

Drills coal, slate, medium rock,. etc., and for use in low veins where it is not practical to use a grip machine. Drill bits and post any length desired. Weight of complete machine 50 lbs.

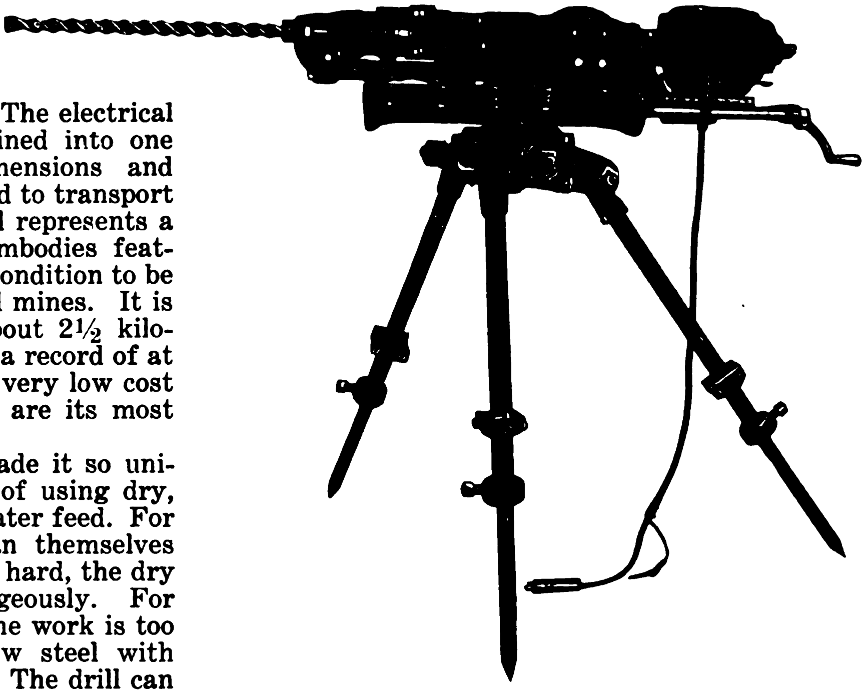


The Pneumelectric Machine Company

SYRACUSE, N. Y.

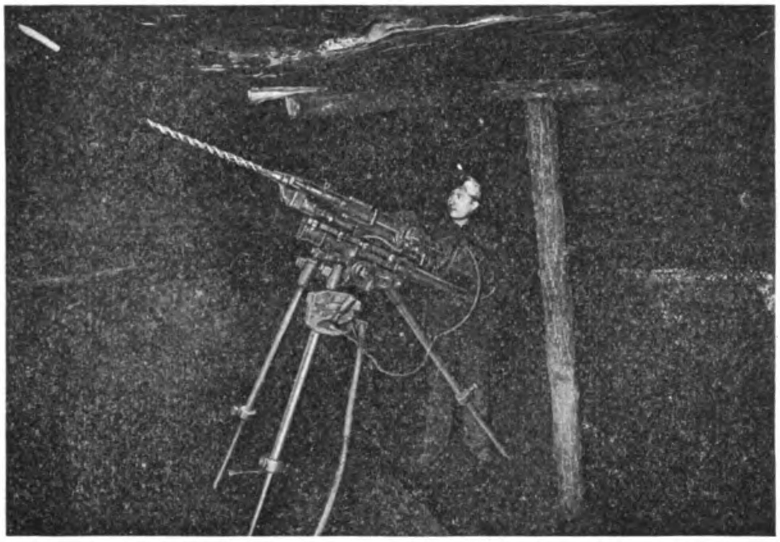
Pneumelectric
TRADE MARK

Electric Rock Drill



An electrically operated rock drill particularly adapted to coal mine work. The blow is produced by compressed air which is compressed and utilized in the same cylinder. The electrical and compressed air parts are combined into one complete compact machine of dimensions and weight that make it easy to handle and to transport from one point to another. This drill represents a development of several years and embodies features that make it applicable to every condition to be met with in removing rock about coal mines. It is a very rapid driller, requires but about 2½ kilowatts input for its operation, and has a record of at least 2½ years constant service with very low cost of upkeep. Reliability and economy are its most attractive features.

One of the features that have made it so universally applicable is the possibility of using dry, twisted steels or hollow steels with water feed. For up holes or such holes as will clean themselves readily, and where the rock is not too hard, the dry twisted steels can be used advantageously. For down holes or drilling in hard rock, the work is too slow with dry steels and the hollow steel with water feed will give the best results. The drill can be adapted to the use of either kind of steels as the conditions may require from time to time.



The Pneumelectric drills are furnished with motors suitable for either direct or alternating current, as may be required, and are constructed for mounting on either tripod or column. It has been found that the tripod mounting is generally best suited for coal mine work. In writing, give kind of power, voltage, height of space where drill will be used, and such general information as may be possible regarding the character of the rock and the work to be done.

The records of performance of the Pneumelectric drill fully establish the right to say that it will satisfactorily handle any rock conditions that may be encountered about coal mines, and that its use will result in greater economies and more satisfactory conditions than can be obtained in any other way in connection with the removel of your rock. Records of performance will be supplied if desired.

Scranton Electric Construction Co.

Office and Works SCRANTON, PA.

Manufacturers of

The Scranton Drill

Products

The Scranton Rotary Drill is steel clad and practically weather proof with only two bearings to be lubricated.

The motor is rated 2½ H. P. with 100 per cent overload capacity, wound for any direct current voltage, 110 and 250 volts standards.

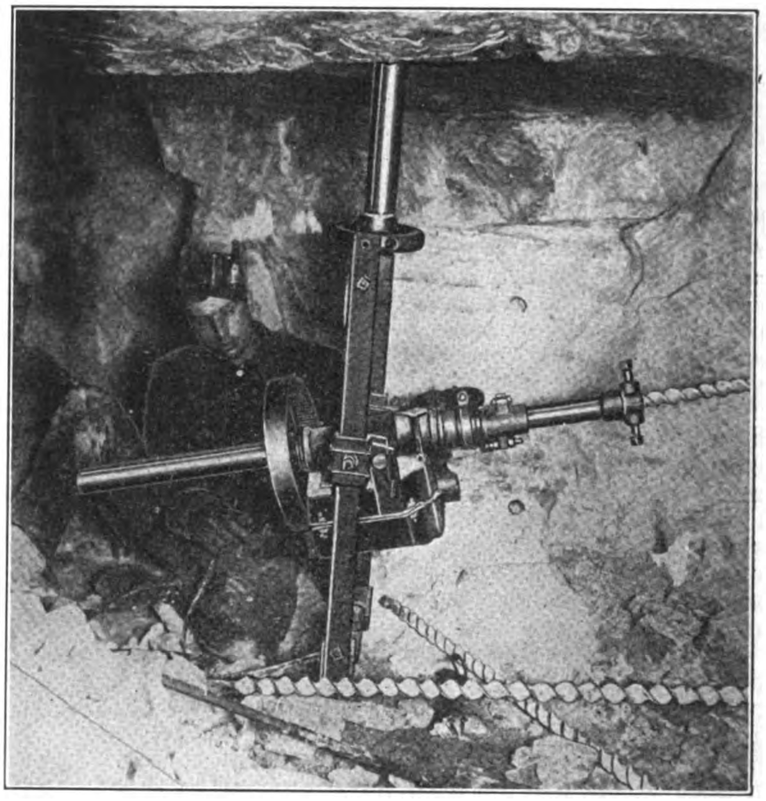
Drill body is of cast steel made in halves with pole pieces and hollow shaft bearings cast integral. These bearings are provided with removable oilless linings.

An internal machine-cut tobin bronze gear is used. This construction prevents accidents to operator and dirt accumalating in the teeth when resting on the ground.

The pinion is of carbon steel, oil treated.

The armature is so designed and proportioned that it gives maximum efficiency with minimum weight. The coils are wound in slots and the winding is so designed that under normal conditions of operation the heating is well within conservative limit, thus allowing a wide margin for heavy overload without injury or sparking.

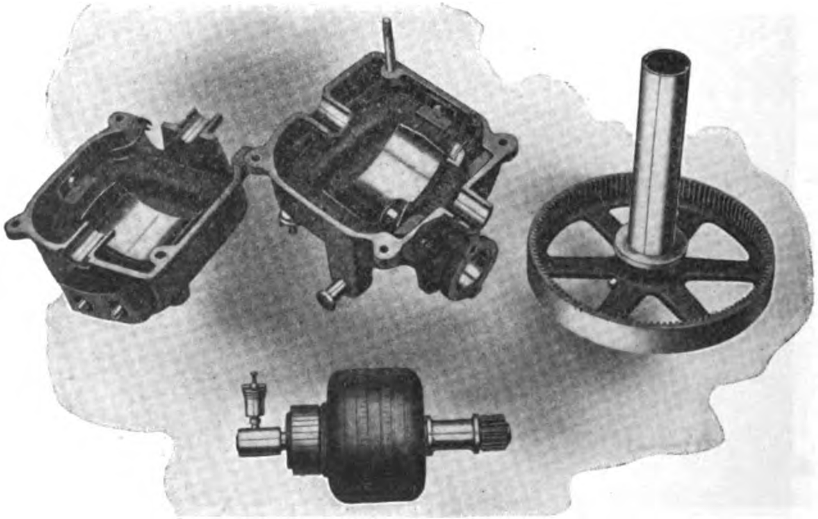
All parts are made to gauge and templet and are interchanbeable.



Showing Scranton Drill in a Low Vein of Coal.

The Scranton Drill may be used with either single or double column, according to the mine conditions. The cables are connected to the drill by means of plug switches, either one of which may be used for controlling the motor. No resistance is required for starting.

The drills are furnished with 1½ in. solid or two in. hollow feed bars with any thread from 5 to 14 as the local conditions may require. For salt and coal an 8 ft. auger passing through the center of a 5 ft. feed bar is used, the auger being held in place by means of set screws in a chuck. In harder substances solid feed bars and chucks are used, with augers of graded lengths; and for extreme cases double reduction gears are furnished.



Showing the simplicity of the Scranton Drill.

THE THEW AUTOMATIC SHOVEL CO.

Factory and Office, Lorain, Ohio. U. S. A.

Manufacturers of

Full Circle Swing Shovels

Products

Full Circle Swing Shovels for operation with steam, air, gasoline, and electric power.

Uses

Thew Shovels are used in the coal field both underground and on the surface. Fig. 1 shows our Type A-I in anthracite stripping. Its use however is not limited to anthracite stripping; it is also used for loading coal after it is stripped. Fig. 4 shows our Type I electric mining shovel mining coal underground. This shovel is built for this work the overall clearance height being 12 feet. It is equipped with the full circle swing and horizontal crowding motion, features of the Thew Shovel. An overhead clearance height of but 9 feet can be secured with the Type O Electric Mining Shovel.

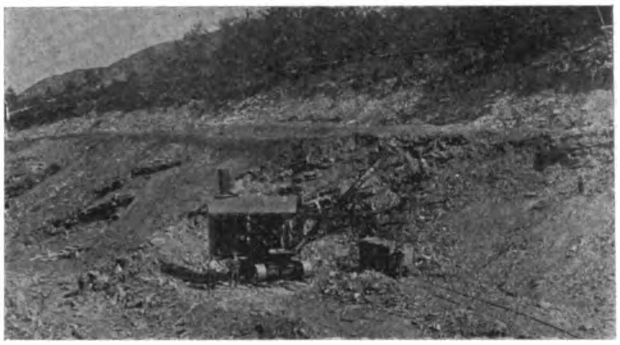


Figure 1.

Thew Features

All Thew Shovels swing in a complete circle. They are capable of negotiating grades as steep as 18% under their own power. Driving clutches are employed to transmit power to the travel wheels. One or both of these clutches can be thrown out as desired, avoiding slippage and strain when turning corners, and enabling the shovel to be hauled by external power without disconnecting the travel mechanism.

The Horizontal Crowding Motion

The horizontal crowding motion is an exclusive feature of the Thew. The action can be seen in Fig. 2.

The dipper is suspended by an adjustable arm, hinged to a trolley or carriage which moves horizontally on a track. When power is applied the dipper moves foreward into the material, enabling the dipper to fill completely in very shallow cuts. In deeper cuts the trolley is moved forward just enough to secure a cut through the face of the bank which will fill the dipper when the cut is completed.

When reaching the end of the stroke, on either the forward or return movement, the trolley engages a trip rod which throws the throttle of the crowding engine into a neutral position. The range of the crowding motion is such as to permit a long forward movement and correspondingly decreases the frequency of changes in position of the shovel.

Through the use of the horizontal crowd the dipper cleans a level floor, thus reducing the hand labor about the machine, and the number of pit men required to a minimum.

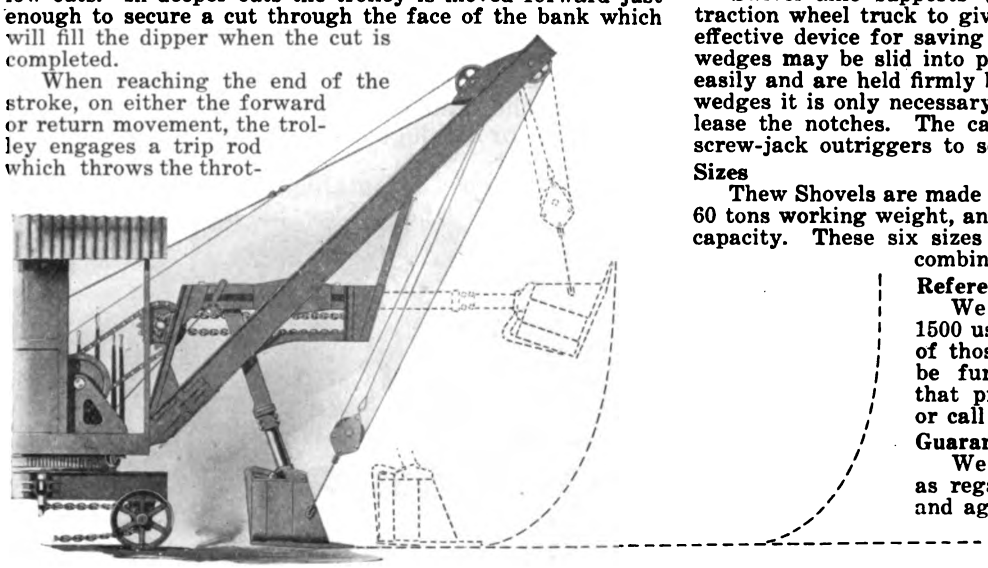


Figure 2.

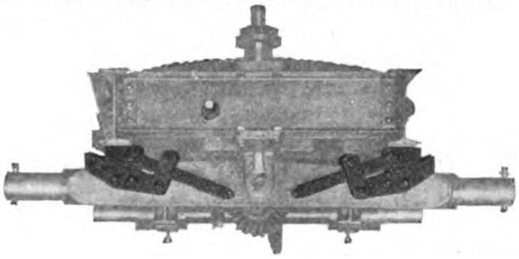


Figure 3. Rear Axle, Showing Swivel Axle Supports.

Trucks

Thew Shovels are furnished with either traction wheel trucks or car wheel trucks. The traction wheel truck can be steered by the usual worm gearing or by turning the machine on the turn table; propulsion being obtained by means of bevel gears.

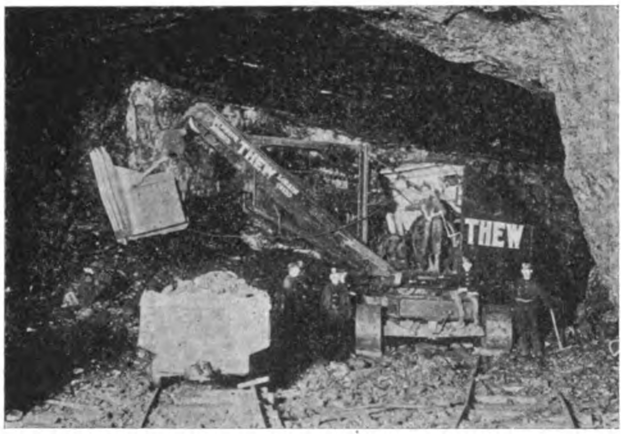


Figure 4.

Swivel axle supports (Fig. 3) are furnished with the traction wheel truck to give rigidity. This is a simple and effective device for saving time and avoiding trouble. The wedges may be slid into place under the truck frame very easily and are held firmly by the notches. To remove these wedges it is only necessary to lift the rod sufficiently to release the notches. The car wheel truck is furnished with screw-jack outriggers to secure the proper stability.

Sizes

Thew Shovels are made in seven sizes ranging from 10 to 60 tons working weight, and with dippers from ½ to 2 yard capacity. These six sizes are furnished in sixty different combinations to suit varying conditions.

References

We refer to any of the more than 1500 users of Thew Shovels. The names of those in any particular district will be furnished upon request, in order that prospective customers may write or call upon them, if they so desire.

Guarantee

We fully guarantee Thew Shovels as regards material and workmanship, and agree to replace free of charge, at Lorain, any parts that prove defective under ordinary usage within six months after delivery.

LAKE SHORE ENGINE WORKS

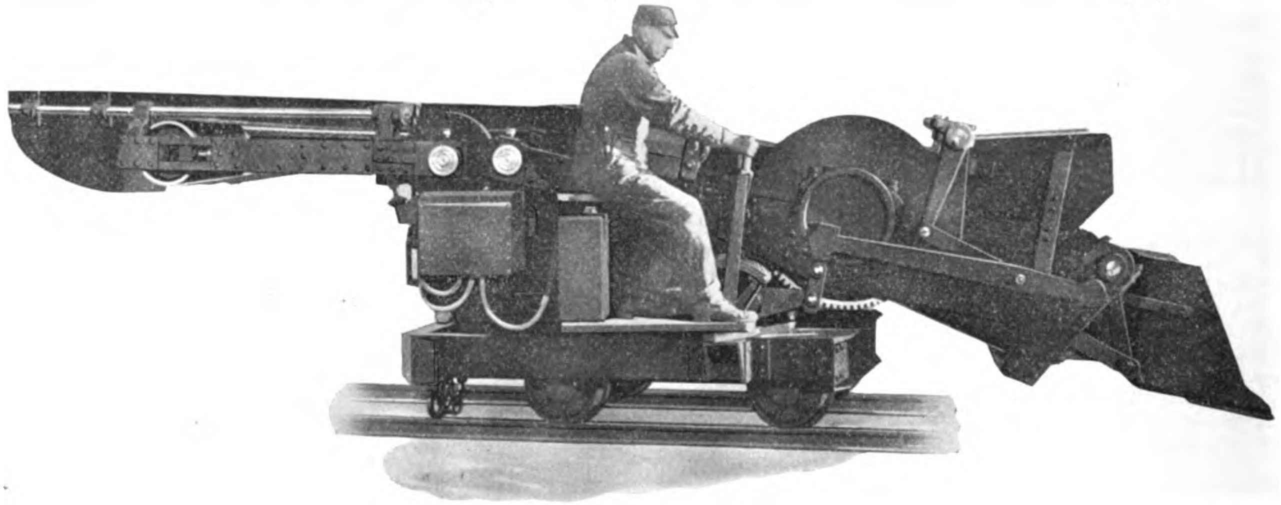
General Office and Works
MARQUETTE, MICHIGAN

HALBY SHOVELING MACHINE

For Underground Shoveling and Loading

The Halby Shoveling Machine is built in three types, in sizes from 7 to 10 tons in weight and for all gauges of track. The machine is self-contained and self-propelled and is designed for shoveling and loading ores, metals, rocks and coal from the pile into mine cars. The two types, T-500 and T-600 shown below, are especially adapted for coal mines.

The Halby Shoveling Machine is arranged for air or electric operation, with the latter recommended. The machine is furnished complete ready for conection to electric wires. It is ordinarily equipped with a 20 H. P. electric motor. All parts are of rugged design and made from materials of the highest quality obtainable. The trucks are equipped with Timken worm drive and Hyatt high duty bearings. In the general construction of the machine will be found heat treated gears, nickel steel shafts, S. K. F. ball bearings, diamond roller chain, and other attachments and devices as are found in successful and substantial equipment.



Model T-500.

Model T-500

Overall length—18′.

Total height with shovel at top position—5′ 6″.

Total height from rail to top of conveyor—4′ 10″.

Width with platform removed—5′ 6″.

Wheel base—42″.

Clearance under rear conveyor—3′ to 3′ 9″.

Total weight—16,000 lbs.

This model is recomemnded where the cars are low and short and where cars are loaded on the same track as the shoveling machine.

Model T-600

Overall length—23′.

Total height with shovel at top position—6′.

Total height from rail to top of conveyor—5′ 10″.

Width with platform removed—5′ 6″.

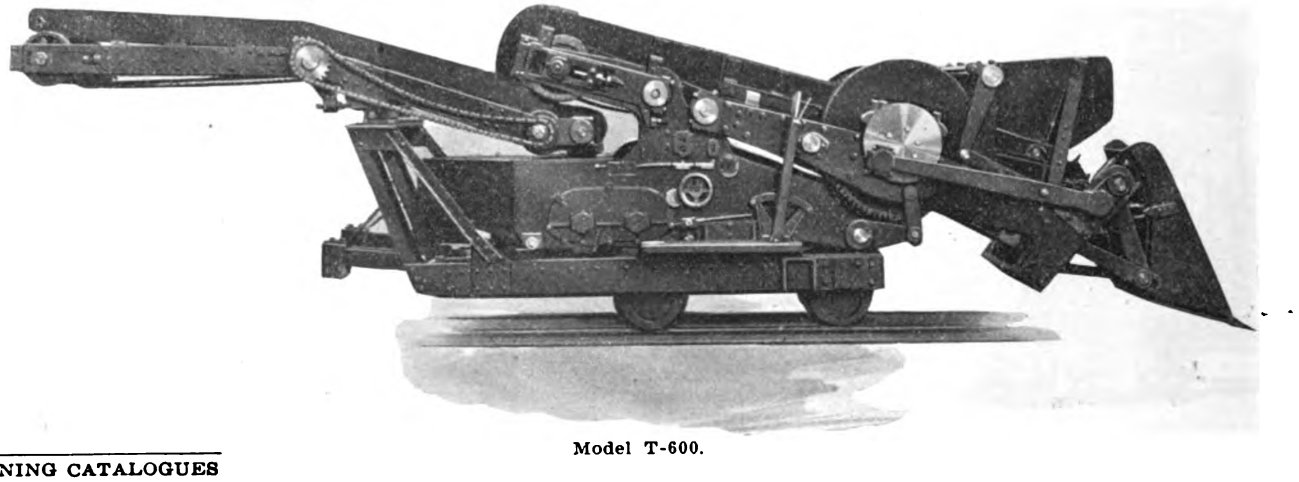
Wheel base—42″.

Clearance under rear conveyor—5′.

Total weight—20,000 lbs.

This model is recommended where long and high cars are used, and in cases where it is desired to load on either the same or parallel track.

Write for catalogues.



Model T-600.

MYERS-WHALEY COMPANY

Factory and Main Office

KNOXVILLE, TENN., U. S. A.

Manufacturers of

Myers-Whaley Shoveling Machines

Products

The Myers-Whaley Shoveling Machine for handling coal and ore in mines, tunnel mucking; and large scale shoveling, handling stock, open pit loading, etc., on the surface.

The Economy of Shoveling Machines In Mining

The foremost saving is in the loading of cars. A full crew consists of one runner and one car coupler, who load as much as 15 to 20 hand shovelers. The second economy, but no less important, lies in the fact that with these machines the same working places can be loaded out twice a day, instead of once in two days, as is commonly the case. Hence a machine equipt mine will produce a given tonnage with one fourth the development required where the loading is by hand.

This extreme concentration, with the consequent reduction of trackage, ventilation and mine car equipment, needs no recommendation.

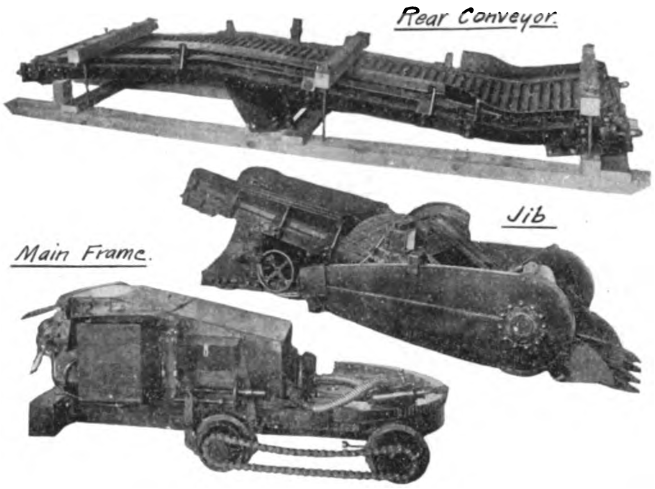


Fig. 1. No. 4 Size Machine Knocked Down—Three Sections.

Construction of the Myers-Whaley Shoveling Machines

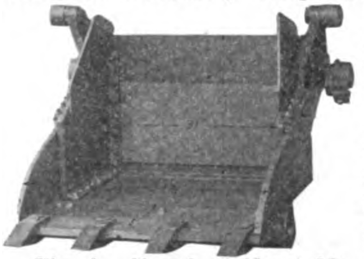


Fig. 2. Shovel of No. 4 Machine. Front section one piece steel casting. Rear section sides each one piece steel casting. Manganese steel lip and teeth.

The best materials obtainable are used and the work is carefully inspected. All gears, except bronze spiral gears, are cut steel, and those subject to the hardest wear are case hardened. All chains are steel. Drive chains are automobile type, finished nickel steel, run on cut steel sprockets.

The strain of the conveyors is taken up by steel roller chains, the abrasion is taken by steel bars. Lubrication in most cases is by closed pressed steel compression grease cups. Brass and white metal linings are provided in most bearings.

Operation

The machine is operated by one man, operates on electricity or compressed air, is self propelling forward or backward. The machine runs on either straight or curved track. or can be equipt with traction wheels. The shovel will work on either a smooth or rough floor, or will spade into the pile above the floor, making its own bottom. The material can be discharged immediately behind the machine, or to either side of the track. The shoveling action is very similar to the motions of hand shoveling, the shovel spading into the pile, elevating the material passing it back to a conveyor which discharges it into the cars. The shovel is mounted on a jib which swings laterally 45 degrees so that a width of 15 to 25 feet can be cleaned up from one track.

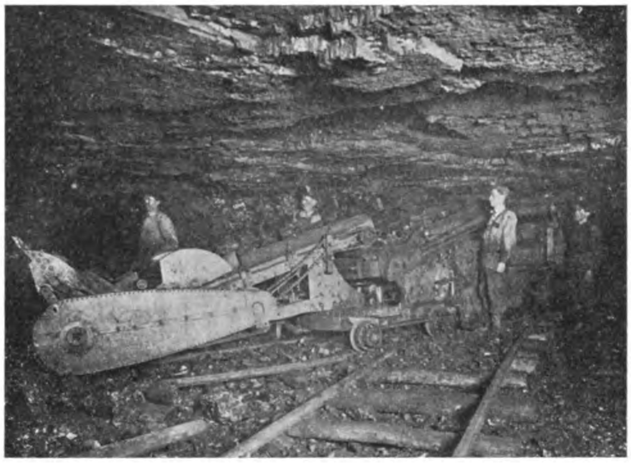


Fig. 3. Machine at Work In a Coal Mine.

The machines operate at the rate of 13 to 18 strokes per minute, with a power consumption of .22 KW Hr. per ton loaded.

Capacities and Sizes

Three sizes are built for underground mining as follows:

Height	Length	Width	Net Wt.	Mine Height Required
No. 2—46".	19 to 21 ft.	4' 9"	9,000	4½ ft.
No. 3—47".	20 to 22 ft.	4'11"	11,000	5 ft.
No. 4—54".	22 to 26 ft.	5'4½"	18,000	6 ft.

The machines are all capable of loading at over 1 ton per minute. The smallest handle 30 to 45 tons per hour, and the larger sizes from 50 to 60 tons per hour, actual shoveling time.

EMPIRE CHEMICAL COMPANY

HUNTINGTON, W. VA

Manufacturers of

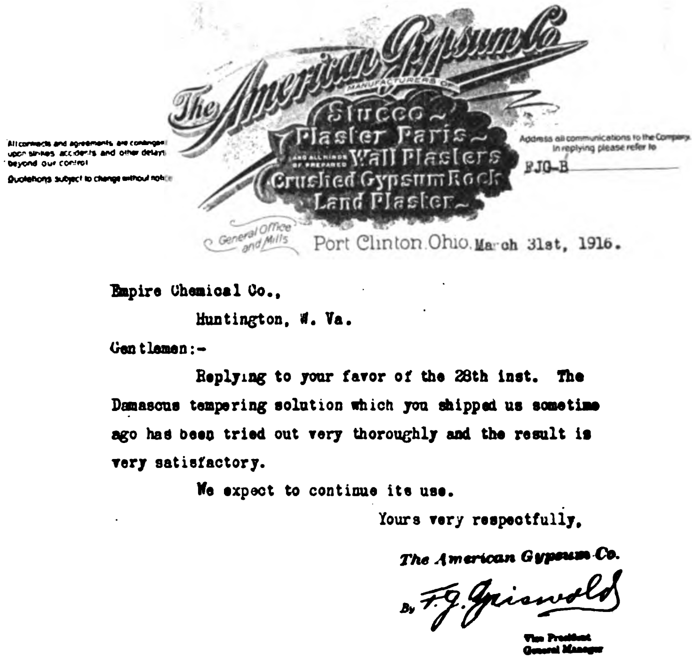
Damascus Tempering Solution

Damascus Tempering Solution will save you money in the production of your coal. The Machine Runner will not have to stop and change his cutting bits,—the Blacksmith's work will be reduced one-half when tempering picks in our solution.

Mines, Mills, Factories, and Quarries are adopting our solution daily.

References on file from every branch of the Industrial World. Shipped in barrels and half barrels under a positive guarantee.

Write us for our liberal proposition.



The American Gypsum Co.
Manufacturers of
Stucco ~ Plaster Paris ~ and all kinds of prepared Wall Plasters
Crushed Gypsum Rock
Land Plaster ~

All contracts and agreements are contingen upon strikes accidents and other delay beyond our control
Quotations subject to change without notice

Address all communications to the Company.
In replying please refer to FJG-B

General Office and Mills
Port Clinton Ohio. March 31st, 1916.

Empire Chemical Co.,
Huntington, W. Va.

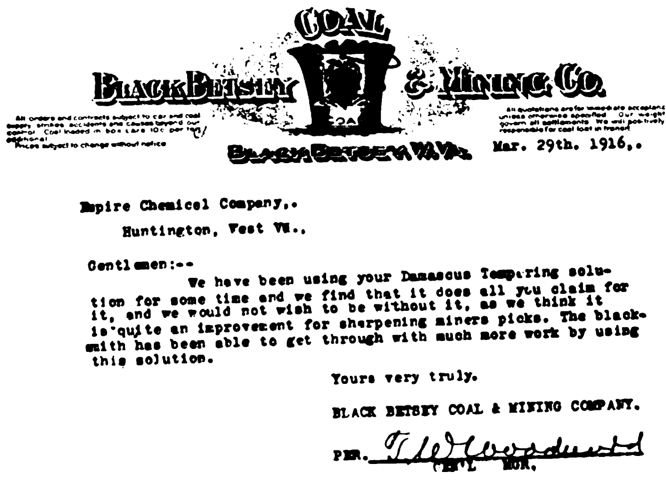
Gentlemen:-

Replying to your favor of the 28th inst. The Damascus tempering solution which you shipped us sometime ago has been tried out very thoroughly and the result is very satisfactory.

We expect to continue its use.

Yours very respectfully,

The American Gypsum Co.
By F. G. Griswold
Vice President
General Manager



COAL
BLACK BETSEY & MINING CO.
BLACK BETSEY, W. VA.

All orders and contracts subject to car and coal supply strikes accidents and causes beyond our control. Coal loaded in box cars 10c per ton additional
Prices subject to change without notice

All quotations are for immediate acceptance only unless otherwise specified. Our weights must govern all settlements. We will positively not be responsible for coal lost in transit.

Mar. 29th. 1916,.

Empire Chemicel Company,.
Huntington, West Va.,

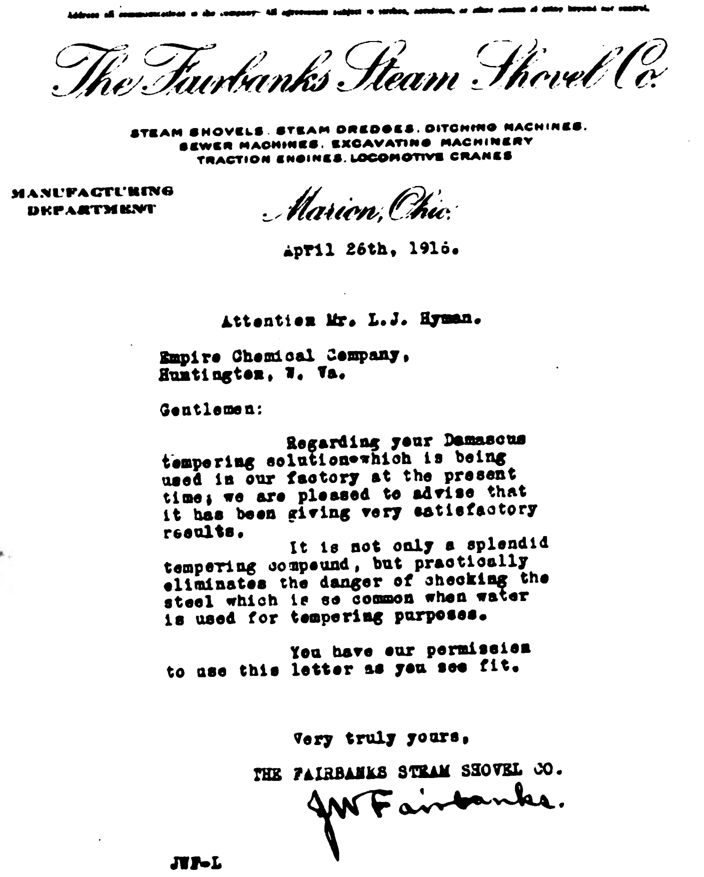
Gentlemen:--

We have been using your Damascus Tempering solution for some time and we find that it does all you claim for it, and we would not wish to be without it, as we think it is quite an improvement for sharpening miners picks. The blacksmith has been able to get through with much more work by using this solution.

Yours very truly.

BLACK BETSEY COAL & MINING COMPANY.

PER. T. W. Woodward
GEN'L MGR.



The Fairbanks Steam Shovel Co.

STEAM SHOVELS. STEAM DREDGES. DITCHING MACHINES.
SEWER MACHINES. EXCAVATING MACHINERY
TRACTION ENGINES. LOCOMOTIVE CRANES

MANUFACTURING DEPARTMENT

Marion, Ohio.
April 26th, 1916.

Attention Mr. L.J. Hyman.

Empire Chemical Company,
Huntington, W. Va.

Gentlemen:

Regarding your Damascus tempering solution which is being used in our factory at the present time; we are pleased to advise that it has been giving very satisfactory results.

It is not only a splendid tempering compound, but practically eliminates the danger of checking the steel which is so common when water is used for tempering purposes.

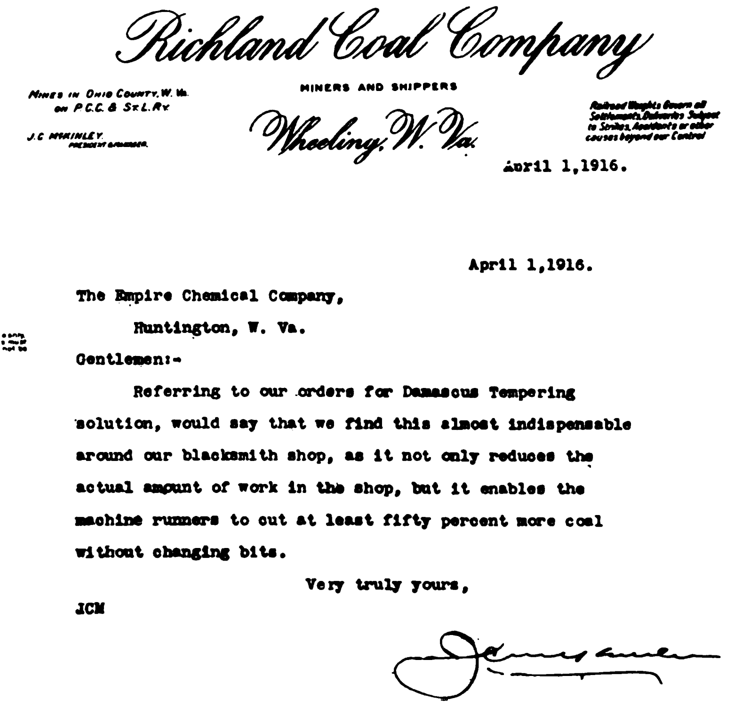
You have our permission to use this letter as you see fit.

Very truly yours,

THE FAIRBANKS STEAM SHOVEL CO.

J W Fairbanks.

JWF-L



Richland Coal Company

MINERS AND SHIPPERS

Mines in Ohio County, W. Va. on P.C.C. & St.L.Ry.

J.C. McKINLEY. PRESIDENT & MANAGER.

Wheeling, W. Va.

Railroad Weights Govern all Settlements. Deliveries Subject to Strikes, Accidents or other causes beyond our Control

April 1,1916.

April 1,1916.

The Empire Chemical Company,
Huntington, W. Va.

Gentlemen:-

Referring to our orders for Damascus Tempering solution, would say that we find this almost indispensable around our blacksmith shop, as it not only reduces the actual amount of work in the shop, but it enables the machine runners to cut at least fifty percent more coal without changing bits.

Very truly yours,

JCM

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

ELECTRICAL SECTION

Treatise
and
Engineering Data

Inquiry Data for Electric Motors.
Electrical Properties of Mine Tracks.
Wiring Formulae.
Ohm's Law.
Alternating Current Formulae.
Equivalent of Electrical Units.
Current for Motors.
Carrying Capacity of Interior Conductors.
Metric System of Weights and Measures.
Conversion Table—Kilowatts and Horse Power.
Speed and Frequency Table for A. C. Apparatus.
Formulae for Transmission Line Calculations.
Constants for Transmission Line Calculations.
Volts Lost with various Copper Wire Combinations.
Volts Drop in Bonded Track.
Properties of Stranded Copper and Aluminum Cable.
Breaking Strain of Copper and Aluminum Cable.
Resistance of Copper Cable.
Weight of Bare Copper Wire.
Diameter and Weights of Insulated Wire and Cable.

The following manufacturers have catalogue descriptions in this section:

American Steel & Wire Co.
American Mine Door Co.
Automatic Reclosing Circuit Breaker Co.
Calebaugh Self-Lubricating Carbon Co.
D. & W. Fuse Co.
Daum, A. F.
Doubleday-Hill Electric Co.
Dudley Elec. & Mch. Co.
Economy Fuse & Mfg. Co.
Ecomony Rail Bond Co.
Electric Railway Equipment Co.
Electric Service Co.
Electric Service Supplies Co.
Flood City Mfg. Co.
Gee Electric Co.
General Electric Co.
Hazard Manufacturing Co.
Iron City Electric Co.
Kester Electric Co.
Le Valley-Vitae Carbon Brush Co.
McCullough, W. T., Electric Co.
Monarch Refillable Fuse Co.
Nagel, W. G. Electric Co., The.
Ohio Brass Co.
Pittsburgh Carbon Brush Co.
Post-Glover Electric Co.
Roebling's John A., Sons Co.
Sackett Mine Supply Co.
Standard Underground Cable Co.
Stackpole Carbon Co.
Sterling Varnish Co., The.
Union Electric Co.
Virginian Electric & Machine Works.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

For additional descriptions of Electrical Equipment, not appearing in this section, refer to Index of Products in front of book.

ELECTRICITY IN MINES.

By E. N. Zern, E. M.*

Part I.

Electricity is a most useful and obedient servant in coal mining. It is used in undercutting the coal previous to blasting; in drilling holes for the explosive, and then for firing the charge; in hauling the coal from the face of the room to the side tracks, and from there to the tipple; for driving the fan which provides us with fresh air; for pumping; lighting; signaling; telephoning; etc.

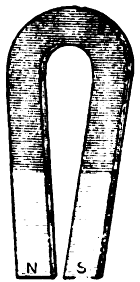


Fig. 1—Horse-shoe Magnet.

Since electricity has become so generally and widely used about the mine, it is well that we should understand something about the principles which govern its generation and transmission.

In the first place, if we take a common horse-shoe magnet, as in Figure 1, and bring close to it a nail, or small piece of iron, we notice that the iron substance is suddenly drawn to the magnet. If we try to remove the nail, we find that force must be exerted to pull it away. This shows that there is a strong attraction between the magnet and the nail.

Let us now cover the magnet with a piece of paper and then sift iron filings evenly over it. By rapping the paper gently with a lead pencil the filings will move at every blow and gradually arrange themselves in lines that show clearly the paths of the LINES OF FORCE, passing from the north pole to the south pole of the magnet. See Figure 2. The important part these lines of force play in the generation of electricity will now be shown.

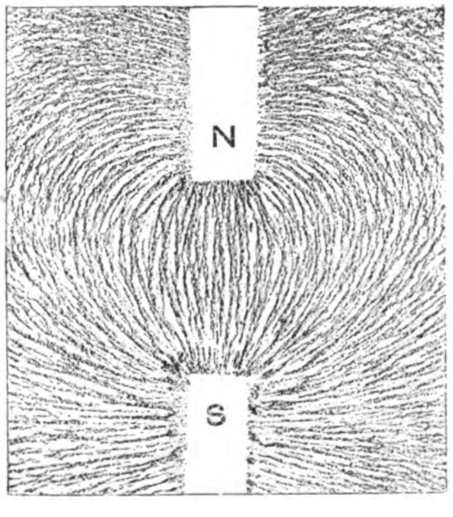


Fig. 2—Lines of force shown by Iron Filings around Poles of a Magnet.

It was learned many years ago that if you passed a bar, or a wire, between the poles of a magnet, as in Figure 3, a current of electricity would flow in the bar **due to the cutting of the lines of force.** It was also found that the faster the bar was moved, or, in other words, the greater the number of lines of force cut in a given period of time, the greater would be the current of electricity generated. This may be shown by attaching the ends of the wires leading from the bar to a GALVANOMETER, which is an instrument used to detect and measure a current of electricity passing through it by the amount of deflection of a needle or other moving part.

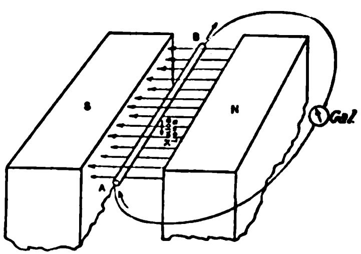


Fig 3—Induced current in a wire cutting lines of force.

If we make a coil by wrapping a wire several times around a broom stick and move it rapidly up and down the pole of a magnet, as shown in Figure 4, a much greater current will be indicated by the galvanometer **because of the increased number of the lines of force cut.**

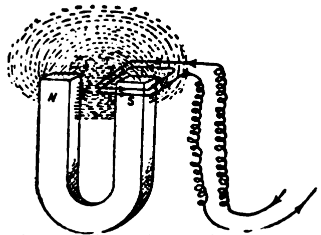


Fig. 4—A coil moving n a magnetic field generates a current.

Bodies, like the wire, which will carry electrical charges readily, are called CONDUCTORS.

Electric currents which are set up in circuits by means of cutting lines of force are known as INDUCED CURRENTS.

The space in which these lines of magnetic force are is known as the MAGNETIC FIELD.

The experiments which have been performed have now made it clear to us that **a tendency for electric currents to flow is produced in a wire (conductor) when it is moved in a magnetic field so as to cut through the lines of force of the field.**

This discovery led to the construction of machines, similar to that shown in Figure 5, in which a coil of wire is made to rotate by hand between the poles of permanent magnets. A machine of this kind is called a MAGNETO. The North and South poles of a magnet are here shown, with the loop of wire placed between them, in such a position that it is capable of revolving. The ends of the coil are connected up to two half sleeves of metal. In contact with these sleeves are two metal strips which are fixed in position and connected to the wire which forms what is called the OUTSIDE CIRCUIT. The motion of the coil towards, and away from the poles, produces currents which change their direction during each revolution, starting at zero and increasing to a maximum as the coil approaches a pole, and decreasing from a maximum to zero as the coil recedes. The currents pass through the loop to the two metal half sleeves, from the half sleeves to the brushes, and thence round the outside circuit. The current, although alternating in the loop, is continuous in the outside circuit, because at the moment the current in the loop changes in direction, the half sleeves interchange brushes, each brush thus receiving its current always in the same direction. This arrangement of half sleeves is called a COMMUTATOR, and is a necessary part of all continuous (direct current) machines.

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*Head of Mining Department, West Virginia University.

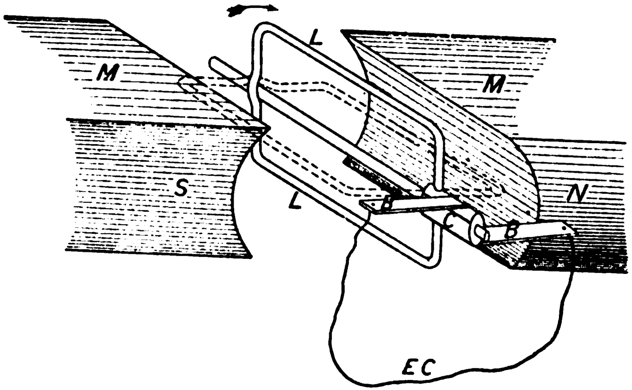

Fig. 5.

B B—Brushes. M M—Magnets.
C—Commutator. E C—External Circuit.
L L—Loops of Wire.

A more powerful magneto than the one just described is used in the automobile for charging batteries and in blasting machines for exploding electric detonators. They are necessarily limited to usage where only small currents are required.

This brings us to the construction of the DYNAMO, which is operated on the same principle as the magneto shown in Figure 5 and differs from it mainly in that:

First, instead of a single loop of wire, a large number of coils of wire are used, making what is known as the ARMATURE.

Second, the coils of wire (conductors) are rotated in the magnetic field by mechanical means instead of by hand. This makes rotation much more rapid and the lines of force cut are therefore greatly increased in a given space of time.

Third, more than one pair of poles are used. This creates a magnetic field for each pair of poles and therefore more lines of force are cut in each revolution of the armature.

Fourth, the commutator, instead of being made of but two parts, consists of as many copper bars, or segments, as there are coils to be commutated.

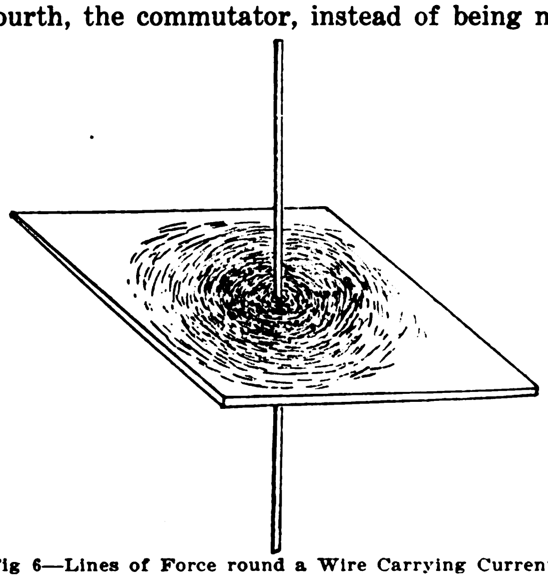

Fig 6—Lines of Force round a Wire Carrying Current.

Fifth, the magnetic field is provided by ELECTRO-MAGNETS instead of by permanent magnets.

It will be seen that the first three of the differences named all serve to vastly increase the lines of force cut, thus enabling the dynamo to send out great quantities of electricity. The last of the differences named will need some additional explanation, since we have introduced a new term, ELECTRO-MAGNET.

We know that an electric current produces a magnetic effect in its immediate surroundings. Pass a current through a wire, as in Figure 6, and it generates lines of force in the surrounding space. The lines form concentric circles round the wire, the magnetic effect decreasing with the distance.

Should the wire carrying the current be wound in a spiral coil, the arrangement is known as a SOLENOID. The distribution of the lines of force of such a system is shown in Figure 7. The magnetic effect of a solenoid is proportional to the current flowing through the wire, and also to the number of turns of wire forming the coil. A soft iron bar inserted between the coils during the passage of the current through the solenoid immediately becomes strongly magnetized, the amount of magnetism thus induced depending on the current flowing and the turns of the solenoid, as already stated. The increase of strength of magnetic field is due to the fact that iron is a much better carrier of lines of force than air, and consequently a larger number of these lines pass through the iron than previously passed through the air gap between the coils. This increase continues, as the current increases up to a certain limit, beyond which no further increase of lines of force is obtainable. The iron core when this point is reached, is spoken of as being in a state of magnetic saturation. The coil of wire, with the iron core, constitutes an ELECTRO-MAGNET.

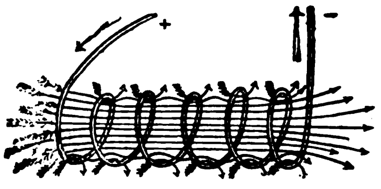

Fig. 7—Magnetic Field within a Solenoid.

It is this form of magnet which is used to make the field magnets of the dynamo. The magnetism induced in the iron core continues so long as the current flows through the wire. On the stoppage of the current, the magnetism of the core dies away, with the exception of the small residual effect, which depends on the quality of the iron. Even this small amount, is, however, sufficient to make the machine self exciting, and is known as the RESIDUAL MAGNETISM in the pole piece.

After developing the electrical energy by the dynamo as already explained, the current is carried to the required place by means of cables or wires and there converted into mechanical energy by means of the motor. It will thus be seen that the function of the motor is exactly the opposite of that of the dynamo, for while the dynamo converts mechanical energy into electrical, the motor converts electrical energy into mechanical energy. In the former case mechanical energy is expended in producing rotation of the armature in the magnetic field; in the latter case this action is reversed. A current from the dynamo is passed through the coils of the armature and field magnets, and the force of the magnetic field so produced, acts upon the coils carrying current in the armature and produces rotation. The force by which the armature is pulled round is called TORQUE, and if a suitable connection be made between the armature shaft and the machinery it is desired to drive, this torque may be made to do work in proportion to its magnitude.

The construction of a motor is practically the same as a dynamo, and any well designed dynamo will act as a motor, but for industrial purposes it is usual to build machines to work solely as motors, as they can be better adapted to fulfill the particular conditions applicable to the case.

Part II.

For all ordinary purposes the action of electricity closely resembles that of water. From the study of the principles which govern the flow and action of water a great deal can be learned concerning the principles and laws governing the action of electricity.

When water flows from a higher to a lower level, it is capable of doing work by driving some kind of a water wheel. The greater the height through which the water falls, the greater the amount of work it can do. The same thing is true of electricity. The greater the difference in electrical level, or difference of potential, or the greater the voltage, the greater the amount of electrical work the electricity can do. The unit of difference of electrical level is the VOLT, and we may say that the volt corresponds to one foot of "head" in a system for developing power by water.

The amount of power that can be developed from a water fall depends on two things: first, the fall in feet or the head, and second, the size of the stream. At Niagara Falls the power that can be developed is staggering in its immensity, not because the height of the fall is so great, but because the size of the stream is so great. Any water fall is capable of developing power, depending on the size of the stream.

The unit of flow may be taken as one gallon per second. The corresponding quality in electricity is called current and its unit is called the AMPERE. The ampere then corresponds to the one gallon per second in a flow of water.

The amount of water that can flow from a higher to a lower level depends on the size of the pipe line through which the water is led. Imagine a dam full of water and twenty-five feet above a river. The amount of water that will flow from the dam through a four-inch pipe is very much greater than what will flow through a ½-inch pipe. Again, if there are two pipes leading from the dam to the river and one is twice the length of the other, about twice as much water will flow through the short pipe as through the long one. The friction of the water is greater in the long pipe, or the resistance to the flow is greater, hence less water flows.

There is no convenient unit for the resistance of a pipe to a flow of water, but the unit of resistance of a wire carrying a current is well defined and is called the OHM.

The resistance offered by a long, short or crooked pipe to the flow of water corresponds to the resistance offered by a wire to the flow of electrical current. The flow from the dam to the river depends on the head. If, instead of having a head of 25 feet, it were increased to 50 feet, the amount of water discharged would be doubled because of the head being doubled. If on the other hand the discharge pipe were made larger, or shorter, even with 25 feet head, twice as much water could be made to escape, from which we see that **the flow of current is inversely proportional to the resistance.**

The relation existing between the flow of water, the head and the resistance can be expressed in the form of a fraction, thus,

$\text{Quantity}=\frac{\text{Pressure}}{\text{Resistance}}$ In a circuit carrying electricity the same thing is true and we have: electrical discharge, or current, equals electrical head or pressure, divided by the electrical friction or resistance. Since the unit of electrical current is the ampere, the unit of electrical pressure is the volt, and the unit of electrical resistance is the ohm, we have: Amperes equals volts divided by ohms, thus,

$$\text{Amperes}=\frac{\text{volts}}{\text{ohms}}$$

This relation is known as Ohm's law and is one of the most important that we shall consider. Since the electrical pressure is what causes the movement of the electrical current, it is called electro-motive force, and as this term is very long it is abbreviated to E.M.F. Since the amperes measure the amount of flow of electricity, such flow is called current, and this is abbreviated to C. Resistance is abbreviated to R. Making use of shortening of terms, we have Ohm's law expressed thus:

$C=\frac{E.M.F.}{R}$ or simply $C=\frac{E}{R}$ when E is used in place of E.M.F. (Sometimes the letter I is used in place of C to designate current.)

To get the general idea of these units we may say that a dry cell such as used to ring door bells has a voltage of 1½ volts. One hundred and ten volts is the electrical pressure usually employed for lighting incandescent lamps. Two hundred and twenty volts is very frequently used for driving motors. Five hundred volts is used on street railroads to propel street cars.

The current taken by an incandescent lamp with a carbon filament is about ½ ampere. The current required by a street arc lamp is from 6 to 10 amperes, depending on the brilliancy of the light.

The resistance of 1000 feet of copper wire one-tenth of an inch in diameter is one ohm. Ten feet of German silver wire, the size of the lead in a pencil, has a resistance of one ohm. The resistance of a mile of the heavy feed wire used in propelling street cars is about one-tenth of an ohm.

We will now consider further Ohm's law and see its application in working out wiring problems about the mines. We have already become familiar with the expression,

$C=\frac{E}{R}$ which we will call formula (1)

The second form of this important equation is,

$E=C\,R$ which we will call formula (2)

The third form is,

$R=\frac{E}{C}$ which we will call formula (3)

These three equations should be carefully studied and memorized. For work in wiring, the second is the most important. Its meaning is that the loss in volts in any part of the circuit depends on the amount of current the wire is carrying and also on the resistance of the wire. If the amount of current carried is doubled, or if an old wire is replaced by a new one of twice the resistance, the loss of volts is doubled. In general, then **the volts lost, or the "drop," is equal to the amperes the wire is carrying multiplied by the ohms of resistance of the wire carrying the current.**

The WATT is the measure of electrical energy and equals one volt times one ampere. 746 watts equals one horsepower, and 1000 watts equals a KILOWATT. A horsepower is therefore very nearly equal to ¾ of a kilowatt.

Let us now apply Ohm's law to a lighting problem, such as we might meet with about the mines. Suppose there were 100 lamps on the three circuits shown in Figure 8 and that they were very close together, so that they all received about the same E.M.F. from the mains M_1 and M_2, but that the dynamo was about 500 feet from the lamps. In such a case the principal loss of pressure would be in the mains carrying current between the dynamo and lamps. Let us assume that we used No. 6 wire, which is .162 inches in diameter, as seen by referring to Table 1, Properties of Bare and Insulated Solid Copper Wire. The table also tells us that there would be a resistance of .395 ohms in the mains, for there are 1000 feet in the two mains. Assuming that 16 c. p. lamps (carbon filament) are used, each lamp will require ½ ampere and the 100 lamps will require 50 amperes.

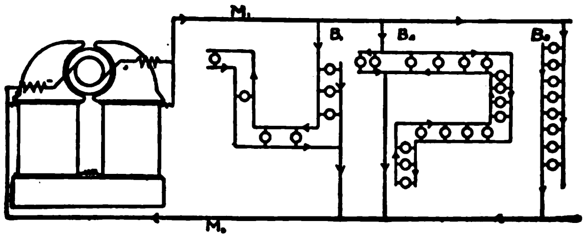

Fig. 8.

Table I—Properties of Bare and Insulated Copper Wire

Size B. & S.	Area		Diameter				Weight—Pounds per 1000 Ft.			Resistance Ohms per 1,000 Ft. at 68 Degrees Fahr.
			Bare		Over Insulation		Bare	Insulated		
	Circular Mils	Square Inches	Inches	Millimeters	3 Braid	2 Braid		3 Braid	2 Braid	
0000	211,600	.16619	.4600	11.683	.640	.609	640.5	767	723	.04893
000	167,772	.13177	.4096	10.404	.593	.562	507.8	629	587	.06170
00	133,079	.10452	.3648	9.266	.515	.500	402.8	502	467	.07780
0	105,625	.08295	.3250	8.251	.500	.468	319.7	407	377	.09811
1	83,694	.06573	.2893	7.348	.453	.422	253.3	316	294	.12370
2	66,358	.05211	.2576	6.544	.437	.390	200.8	260	239	.15600
3	52,624	.04133	.2294	5.827	.406	.359	159.3	199	185	.19670
4	41,738	.03278	.2043	5.190	.359	.328	126.3	164	151	.24800
6	26,244	.02061	.1620	4.115	.328	.296	80.6	112	100	.39440
8	16,512	.01297	.1285	3.263	.296	.250	49.9	75	66	.62710
10	10,384	.00815	.1019	2.588	.234	.203	31.4	53	46	.99720
12	6,528	.00512	.0808	2.052	.203	.172	19.7	35	30	1.58600
14	4,108	.00322	.0641	1.628	.187	.156	12.4	25	20	2.52100
16	2.580	.00202	.0508	1.291	.172	.125	7.8	20	16	4.00900
18	1,624	.00127	.0403	1.024	.156	.109	4.9	16	12	6.37400
20	1,024	.00080	.0320	.8118			3.1	12	9	10.14000

Table II—Properties of Bare and Insulated Stranded Copper Cable

Size B. & S. Gauge	Area		No. of Wires in Strand	Diameter			Weight—Pounds per 1,000 Feet			Resistance Ohms per 1,000 Ft. at 68 Degrees Fahr.
				Bare	Over Insulation		Bare	Insulated		
	Circular Mils	Square Inches			3 Braid	2 Braid		3 Braid	2 Braid	
	2,000,000	1.56874	91	1.6302	2.000	1.875	6204.8	7008	6690	0.00530
	1,750,000	1.36494	91	1.5257	1.906	1.781	5429.3	6193	5894	.00607
	1,500,000	1.17831	91	1.4124	1.781	1.656	4653.6	5380	5098	.00707
	1,250,000	.98170	91	1.2892	1.656	1.531	3878.0	4508	4264	.00852
	1,000,000	.78494	61	1.1520	1.531	1.406	3100.3	3674	3456	.01060
	950,000	.74618	61	1.1232	1.468	1.343	2945.3	3503	3292	.01115
	900,000	.70724	61	1.0935	1.437	1.312	2790.3	3332	3127	.01179
	850,000	.66852	61	1.0629	1.406	1.281	2635.3	3162	2963	.01247
	800,000	.62810	61	1.0305	1.375	1.250	2480.2	2992	2799	.01325
	750,000	.58922	61	.9981	1.343	1.218	2325.2	2822	2635	.01413
	700,000	.54954	61	.9639	1.312	1.187	2170.2	2650	2471	.01514
	650,000	.51020	61	.9288	1.250	1.125	2015.2	2443	2282	.01630
	600,000	.47146	61	.8928	1.234	1.109	1860.2	2235	2093	.01767
	550,000	.43181	37	.8533	1.156	1.031	1703.0	2064	1925	.01925
	500,000	.39237	37	.8134	1.109	1.000	1548.2	1894	1765	.02116
	450,000	.35234	37	.7721	1.062	.937	1393.4	1724	1601	.02349
	400,000	.31431	37	.7280	1.031	.906	1238.5	1553	1436	.02648
	350,000	.27511	19	.6785	.968	.843	1083.34	1345	1248	.03026
	300,000	.23591	19	.6285	.921	.796	926.01	1174	1083	.03531
	250,000	.19635	19	.5738	.875	.750	771.67	985	907	.04233
0000	211,600	.16609	19	.5275	.812	.687	653.14	800	745	.04997
000	167,772	.13185	7	.4644	.734	.671	512.07	653	604	.06293
00	133,079	.10429	7	.4134	.687	.625	406.98	522	482	.07935
0	105,625	.08303	7	.3684	.640	.578	322.39	424	388	.10007
1	83,694	.06599	7	.3279	.593	.531	255.45	328	303	.12617
2	66,358	.05205	7	.2919	.531	.468	202.50	270	246	.15725
3	52,624	.04132	7	.2601	.468	.421	160.60	206	190	.19827
4	41,738	.03276	7	.2316	.437	.390	127.40	170	155	.25000
6	26,244	.02059	7	.1836	.406	.359	80.10	115	103	.39767

By formula 2, we have volts lost in mains, or drop, equals amperes multiplied by ohms, or

50 times .395 equals 19.75 volts drop.

In this case, if the lamps were to be supplied with 110 volts, the dynamo would have to produce 110 volts plus 19.75 volts, or 129.75 volts. This is a large drop, but if carefully operated such a great loss as 20 volts in the mains might be allowed. The more ordinary case in mine lighting, however, is one in which the lamps are about equally distributed between the dynamo and the end of the circuit. In such a case a drop of 20 volts in the mains would not be permissible, for then the lamps near the dynamo would get around 130 volts and those at the end of the circuit would get 110 volts. This is altogether too much variation. The greatest variation that should be allowed is eight volts, and all well regulated plants do not have more than two. This uniformity in voltage is well repaid by the increased life and efficiency of the lamps. For example, if a lamp has a life of 800 hours at 110 volts, it will not have more than 200 hours at 115 volts, and moreover, it will not give more than two-thirds of its light.

Problem No. 2. A mine fan, located 600 feet from the power house is electrically driven. Current is generated at 220 volts and the motor requires 150 amperes. A No. 00 wire is used for carrying the current. What is the voltage at the fan motor?

Solution: E=C R. Referring again to Table I, we find that the resistance in ohms per 1000 feet of No. 00 wire is .07780. Then

$E=150\times.07780=11.67$ volts drop in 1000 feet.

Since the length of wire used is 1200 feet, we have

$11.67\times\frac{1200}{1000}=14.00$ volts drop in 1200 feet.

$220-14=206$ volts at the fan motor

In both of the preceding problems we have assumed a certain size of wire in use and then calculated the drop in voltage. **It is far better practice in mining work to know how many volts drop you are willing to allow, and then calculate the size of wire necessary so that the allowance shall not be exceeded.**

We will illustrate this with Problem 3. A mine 300 feet deep is to be illuminated at the shaft bottom with 80 lamps of 40 watts each. Current is generated at 110 volts. What size wire should be used so that the drop will be no greater than 5 per cent? The generator is 200 feet from the shaft and the most distant lamp from the shaft is 600 feet.

Solution: 80 lamps at 40 watts each will require a total of 3200 watts. Since the current is at 110 volts, and remembering that a watt is equal to one volt times one ampere, we have,

$$\frac{3200}{110}=29.08 \text{ amperes}$$

$$110\times.05=5.50 \text{ volts drop allowed}$$

$$2(200+300+600)=2200 \text{ feet of wire}$$

(Since the spacing of the lamps is not given in the problem, the distance to the last lamp is taken.)

Using formula 3,

$$R=\frac{E}{C}=\frac{5.5}{29.09}=.1891 \text{ ohms resistance in 2200 feet}$$

$$.1891\times\frac{1000}{2200}=.08595=\text{resistance allowable in 1000 feet of wire}$$

Now referring to the table we find that No. 00 has a lower resistance and No. 0 a higher resistance than the amount to be allowed. To be on the safe side we will specify a No. 00 wire.

The trolley wire used in mine haulage is usually from No. 00 to No. 0000 in size, and round, figure 8, or grooved in shape. If the haul is of great length, and cutting machines, pumps, etc., are at some distancef rom the generator, feeders should be supplied. These are large wires running from the dynamo, and cross connected to the trolley wire at various points. Problem No. 4: We will now assume that a feeder is to be selected of sufficient size to carry one mile into a mine, 300 amperes at 550 volts pressure at the generator. The drop, or loss is not to exceed 50 volts. What size feeder should be chosen?

Solution:

$$R=\frac{E}{C}=\frac{50}{300}=.1667 \text{ ohms resistance in 1 mile}$$

$$.1667\times\frac{1000}{5280}=.0316 \text{ ohms resistance in 100 feet}$$

From the Table II of resistances, we find required a standard wire having a cross section of 350,000 circular mils*, or .275 square inches of area. It would be preferable, however, to use two No. 000 wires having a cross section each of .132 square inches as the equivalent of the stranded cable, since it would be easier to handle and splice in the mine.

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*A circular mil is a unit of area employed in measuring the areas of cross sections in wires, and is equal to .78540 square mils. It is equal to the area of a circle one mil in diameter. A mil is a unit of length and is equal to 1/1000 of an inch.

Part III.

Electricity has greatly reduced the cost of coal mining in its various phases. Its advantages are many, disadvantages few. Its disadvantages are the danger to man and beast when certain voltages are exceeded; fire is apt to be started by contact of the wire with coal; and explosive gas may be ignited. The voltage on mine circuits vary from 220 to 600 volts. Low pressure circuits are those having 250 volts and under; medium from 250 to 600 and high pressure everything above 600 volts.

In the use of electricity there is a choice between direct current and alternating current. Direct current is found largely in inside mine work, and both direct current and alternating current for outside work. When an operation consists of only one mine, with current generated at the mine, direct current is almost universally used, and we will consider such installation first.

The choice of voltage will be between 220 and 600, which latter is about the high limit in direct current generation for mining work. The low voltages offer more safety, with high costs for copper, while the high voltages are more dangerous with lower costs for copper. There are two great principles in the transmission of current. First, the **cost of copper wire varies inversely as the square of the voltage.** Thus, supposing 2000 lbs. of copper are required to transmit a given quantity of power a certain distance with a given percentage of loss in the conductors at 50 volts pressure, only 125 lbs. will be necessary if the pressure is increased to 200 volts. $200 \times (\frac{1}{4})^2 = 125$ lbs. Second, **the heating effect of the current on the wires, and the consequent loss of energy in transmission, is determined by the amperes which are carried.** Thus, if current is generated at 250 volts, and a load of 1000 amperes is transmitted over a given line, the total energy will be expressed as 250 kilowatts (abbreviated form, k. w). If this same current of 1000 amperes is generated at 500 volts, the energy will be 500 k. w. The transmission wire for carrying 250 k. w. at 250 volts could be used equally well for transmitting 500 k. w. at 500 volts. Similarly, if the voltage were raised to eight times the amount, or 2000 volts, then 2000 k. w. could be transmitted over the same wire, since the amperes are the same.

The limit of transmission of direct current at 250 volts may be taken at one mile, since beyond this point there is a large drop in voltage. The increasing tendency, therefore, is to install 500 to 600 volt plants and take extra precautions in the system in wiring. The range of distribution for this latter voltage may be taken as four miles.

The three-wire system affords considerable economy in the use of copper and it is used in some mines. By this means 550 volts can be taken from the generator and divided in half, using two currents of 275 volts each. This permits of a saving of 25% in copper on the feeder, when figured on a basis of current capacity, or a saving of 62½% when figured on a basis of drop of potential, and when the neutral wire is considered as equal in size to the outside. See figure 9.

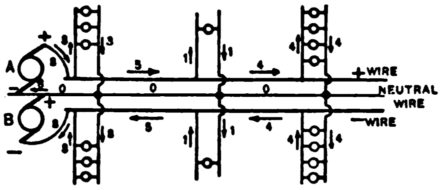


Fig. 9. Balanced Three-Wire System.

We will now consider the case where two or more mines, closely grouped, are to be operated by electricity. Two courses are open. First, to install an electrical plant at each of the mines, or second, to erect at the plant most centrally located an alternating current power plant of high voltage and transmit the current at high voltage as needed to the other mines. This will be handled at the different mines by sub-stations. The advantages of a central power plant over individual plants at each mine, are:

Water and fuel are needed at only one place.

Minimum outlay for copper.

Less foundation expense, since expensive foundations are not required at sub-stations.

Reduction in the number of employes.

Good working voltages can be better maintained.

Lower cost of oil and waste.

More flexibility in mining operations.

Sub-stations can be installed and feed lines dropped through bore holes at places where it would be impossible to install a power plant.

Economy in operation.

In the use of a central power plant, the alternating current is changed into direct current at the sub-stations by a rotary converter, or by a motor generator set. The equipment in the sub-station, in addition to either of these, will comprise a switch board, protective apparatus, and other details similar to power house equipment, but not on so large a scale. On account of the dangers of high voltage circuits, transformers are frequently installed in sub-stations to reduce the voltage to about 440 volts before sending it to the converter.

Wiring of Mines

All feed lines should be bare copper; first, because they will always be respected as such, and second, because insulation deteriorates so rapidly in mines as to be worthless. All wires should be properly insulated from the coal, as cases are on record where fires have been started by faulty insulation. For the same reason, wires should not be permitted in contact with brattice cloth, doors, props, or against the coal. A wise precaution is never to place electric wires in headings where they cannot be observed at least once each day.

Trolley wire should be carried at a uniform distance of from 6 to 8 inches to the outside of the rail. The power for undercutting machines and pumps should be taken from separate circuits. These should be carried along the side of the entry —the same side as the trolley wire is on—from 18 to 24 inches apart. and the end of the negative wire connected to the last bonded rail. Each section of the mine should have a cut out switch so that troubles can be localized, and at the mine entrance the wires should be connected with an arrester. For safety, inverted troughs are used over trolley wires where men or live stock must pass under.

Bonding is an important, though oft-times neglected, element in successful electrical operation. It is in reality a difficult matter to effect a good electrical return, because in mines we have to contend against light and springy rails, soft road bed, in insufficient number of ties, loose joints and fish plates, corrosive mine water, etc., etc., which are not found in surface work. Two systems of bonding are employed: first, wherein the bonds are placed outside the fish plates, and second, where the bonds are placed inside the fish plates. Bonds placed outside the fish plates are apt to be loosened or broken by the hoofs of live stock, or by derailed cars, but they have the advantage of being easily inspected. Bonds held under the plates lose their flexibility in time, and occasionally work loose in the rails. They can be inspected only at considerable expense, but are not subject to the same mishaps as the exposed bond. A practice adopted by many companies is to weld the rails electrically. Rails should be cross bonded at intervals of about 200 feet, and all switches should be cross bonded. The return wires from machine or pump circuits should be cross bonded with these rails. Where pipe lines run parallel to the mine track, they should be connected to track and the pipe line made electrically continuous. This will prevent electrolysis.

Considerable trouble is usually experienced with wires in a shaft owing to short circuits and grounding. This is principally due to the wetness of the shaft, and injury caused by falling pieces of coal, etc. Many different methods of overcoming this difficulty have been tried with varying results. Wood casing all through the shaft, and the employment of lead and rubber covered cables have been tried but with indifferent success. A cable that gives good results is one insulated with vulcanized India rubber and braided on top. This is protected from injury by a galvanized iron or steel wire sheathing. Shaft cables are sometimes run in iron piping which is clamped to the brick or wood lining of the shaft. The pipe can be filled with clean dry sand, or closed at both ends with tar or cement to exclude moisture.

Several manufacturers have placed on the market a fibre conduit which is used to enclose wires in a shaft, serving well the double purpose of insulation and protection. This conduit has a solid, homogeneous wall ¾ inch thick, and is moulded into pipe varying in inside diameter from one to four inches, and in weight from .45 to 3.2 pounds per foot. The conduit is supported by clamps to the shaft timbers, and is made air and moisture proof throughout by sealing the top and bottom. The wire is unsupported within the conduit. The fibre will not only securely insulate the wire, but is amply tough and strong to withstand blows from falling coal.

The table herewith gives the approximate drop in voltage of a 250 volt two-wire system with conditions of trolley and feeder as ordinarily encountered in the average coal mine.

Loss of Voltage in Mines (Two Wire System)

250 Volts at Mine Entrance. Track Resistance Equal to Overhead Resistance, 100 Amperes in Circuit.

Distance in Mine in Feet	Volts Loss			Volts Between Track and Trolley		
	One 4-0 Trolley Only	One 4-0 Trolley and one 4-0 Feeder	One 4-0 Trolley and two 4-0 Feeders	One 4-0 Trolley Only	One 4-0 Trolley and one 4-0 Feeder	One 4-0 Trolley and two 4-0 Feeders
1,000	10	5	3	240	245	247
2,000	19	10	6	231	240	244
3,000	29	14	10	221	236	240
4,000	39	19	13	211	231	237
5,000	49	24	16	201	226	234
6,000	59	29	20	191	221	230
7,000	68	34	23	182	216	227
8,000	78	39	26	172	211	224
9,000	88	44	29	162	206	221
10,000	98	48	33	152	201	214
12,000	117	59	39	133	191	211
15,000	146	73	49	104	177	201

To Find Voltage at Any Other Current:—Divide current in amperes by 100 and multiply the result by the volts loss in the table.

Example:—Required, voltage between trolley and track, in a mine using 4-0 trolley and one 4-0 feeder at a point 3000 feet from the mine entrance. Current 500 amperes.

Solution:—Volts loss with 4-0 trolley and 4-0 feeder at 3000 feet equals 14. 500 amperes divided by 100 equals 5. 5 multiplied by 14 equals 70 equals volts loss. 250 volts at mine entrance less 70 volts loss equals 180 volts between trolley and track.

To find loss in mine using 3-0 trolley or feeder, multiply loss in Table by 1.261.

To find loss in mine using 2-0 trolley or feeder multiply volts loss in table by 1.509.

Example:—Required, voltage in mine using 3-0 trolley and two 3-0 feeders at a point 5,000 feet from the mine entrance, current 100 amperes.

Solution:—Look in Table and find under one 4-0 trolley and two 4-0 feeders and opposite 5,000 feet the loss to be 16 volts. Multiply 16 by 1.261, which gives 20 volts. 250 volts minus 20 volts equals 230 volts equals answer.

To find current taken by a 250 volt motor, multiply the horsepower by three.

To find current taken by a 500 volt motor, multiply the horse power by one and one-half.

It would be extremely difficult to lay down rules for the installation of the overhead circuit in all mines, but the following rules, if carried out, will materially increase the efficiency of the electrical circuit.

A. Install all mine wiring for power on approved porcelain or glass insulators with steel or wood pins as a support. They should be placed as often as twenty feet for low roof and not to exceed 35 feet for high roof. Porcelain insulators, if thoroughly vitrified are preferred to glass.

B. Install only one wire on each insulator, securely tying it to the insulator with a tie wire, preferably of the same material as the conductor. This would not of course apply to lead covered conductors. Tie wire should be preferably No. 4 wire.

C. Install all trolley wire hangers practically at the same height from the top of the rails, so as to bring the trolley wire as nearly on a level as possible. This will eliminate jumping of the trolley wheel and also arcing to a certain extent. The center of each hanger should be plumbed at a certain distance outside the outer edge of track rail. This distance is governed by the mining laws of different states, and also by the size and type of locomotive used.

The severest stress which can be placed upon a hanger and especially upon the insulation, is that encountered on a curve, and in railway practice pull-offs are used to take care of the strain on the curve, but as railway pull-offs are not practical in mines (especially in the low-veined type), a sufficient number of hangers should be installed on the curve to prevent the studs of the hangers being bent and the trolley clamps from being distorted. No fixed rule can be laid down for this as it depends entirely on the strains induced by the trolley wire and the degree of the curve; but, generally speaking, hangers should be placed from 6 to 10 feet apart on curves. For curve work, it is good practice to use a clamp in which the boss comes tightly against the insulation when the clamp is lined up. This will prevent to a certain extent the bending of the stud (See Fig. 10). Where pull-offs can be used they should be guyed with No. 6 galvanized steel wire and should have a conical strain insulator cut in the wire. Timber hangers, as the name would imply, are designed to be attached directly to mine timbers, but in a large number of mines it has been the custom to attach the timber hangers directly to the mine roof, either by means of suitable expansion bolts or wooden plugs driven into holes in the roof, and the hanger installed by means of lag bolts. This practice is not so good as if installed on a timber or a small block, still it has proved satisfactory in service. The insulation resistance of the hanger is the same as that of an expansion-bolt hanger, and, consequently, leakage would be the same.

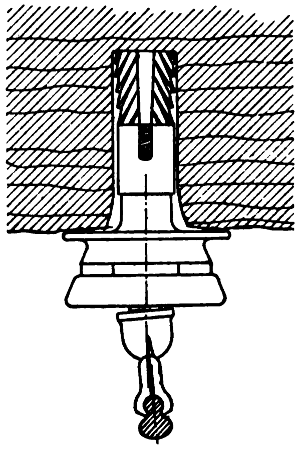


Fig. 10.

Expansion bolt hangers are provided with a boss into which the end of the expansion bolt may be screwed. The hanger is usually provided with a hexagonal body so that a wrench may be applied. Spikes and nails should not be used for attaching hangers of any kind to their supports. Steel mine timbers are rapidly coming into use for timbering main entries, and a very good installation for trolley and feeder may be made by fastening the hangers directly to the bottom of the I-beams. Clamps for fastening the hanger to the I-beams are now on the market.

D. The subject of the proper placing of a trolley frog or switch pan, as it is sometimes called, has frequently been brought to the writer's attention, and on account of various sizes of locomotives used, it is a rather difficult matter to determine. Circular No. 23 of the Bureau of Standards recommends that frogs be placed 10 to 12 feet back from point of latch and held in horizontal position by properly placing hangers on the line near frogs. It has been the writer's experience that the distance specified will be satisfactory for most of the conditions encountered in mines.

Trolley frogs are provided as a rule with four pull-off rings or eyes, so that they may be guyed to a proper position by the use of guy wires. Never attach a guy wire on a frog or any other trolley device which is to carry current, without cutting in a conical strain insulator in the guy which will properly insulate it. Frogs should always be placed on branches leaving the main trolley.

Malleable iron trolley frogs are now making their appearance upon the market and can be used to advantage in mine service.

E. When dead-ending a trolley wire, it should be securely anchored and insulated, either by use of a conical strain insulator and ordinary turnbuckle, or a strain insulator, which is a combination of the above two mentioned, or other suitable insulator. A suitable galvanized clamp should be used for holding the dead-end loop at the end of the trolley wire. (See Fig. 11).

F. Allow proper clearances in all cases for the trolley wheel. It is extremely bad practice to allow the wheel to touch the roof, even though the roof may be hard sandstone or other formation, as it increases wear on the wheel and is generally unsatisfactory. It is still better to shoot down a little of the top and get a proper clearance, where conditions will permit.

G. The manner of making the proper connection at a point where the feeder is to be tapped into the trolley wire, should receive careful consideration. The practice of hooking feeders around the trolley clamps should not be permitted, as they invariably work loose and cause trouble. A high resistance will generate considerable heat and will produce a very vicious arc which will probably burn off the feeder. It is recommended that a good form of feeder ear or clamp be employed, and where the feeder is of such size that it will not fit the ear, two or even three should be installed at that point and suitable taps run from the feeder proper to the ears. (See Fig. 12). The total area of copper in circular mils in the taps should be equal to the area in circular mils of the cable. Feed-in yokes, made especially for feeding-in purposes, may be purchased in the market and will be found satisfactory for this purpose.

H. The selection of proper trolley clamps is a matter that should receive proper consideration. Clamps have been designed which are too long and which, when the hanger is installed slightly out of plumb, produce a hump or projection in the trolley wire which invariably causes arcing as the trolley wheel passes the clamp. (See Fig. 13). The clamp should be narrow so that the wheel will pass it without striking, and the nut or other clamping means should be located high enough on the clamp proper so as not to strike a badly worn trolley

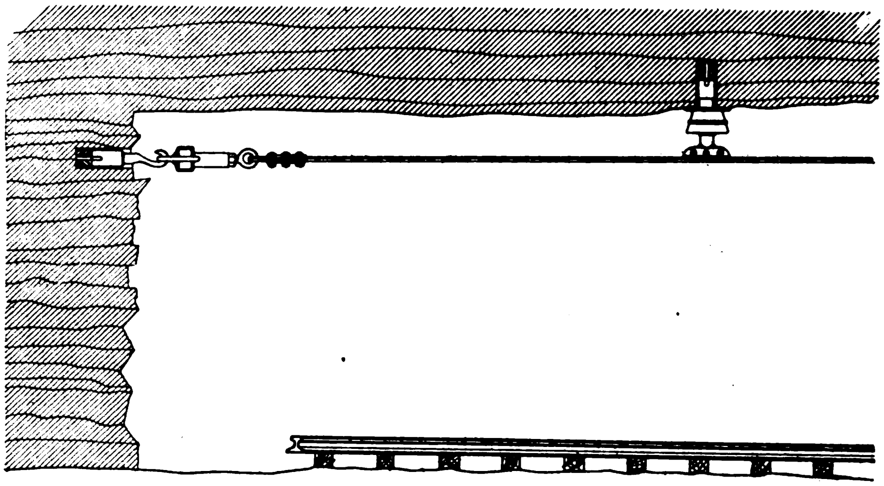


Fig. 11.

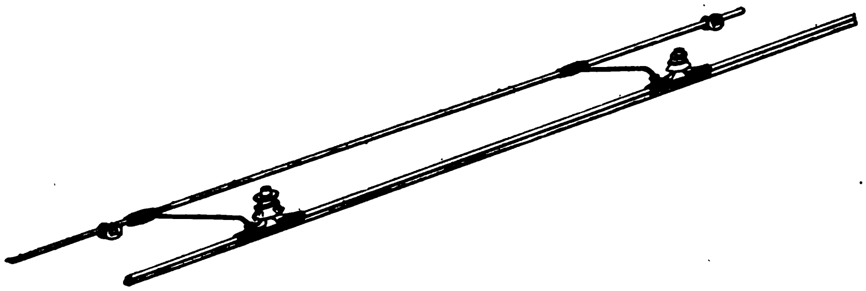


Fig. 12.

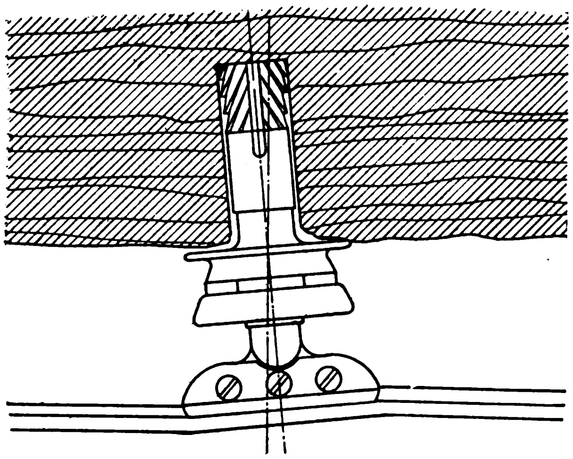


Fig. 13.

wheel. A great deal of sparking of the trolley at hanger point could be minimized by the use of a well-designed clamp and keeping the hangers carefully plumbed.

I. Splices in the electrical circuit should be made with care, as it is astonishing to observe the drop in voltage caused from poorly made joints. Splices in the trolley circuit may be made by suitable splicers designed for this purpose, and may be either soldered or mechanical. Splices in feeders should be made by the use of a good splicer and may be either of the soldered or mechanical type.

It is known that where two dissimlar materials are joined together, as would be the case where two copper wires were joined by means of a soldered connector, that due to the excessively moist atmosphere there will be set up a local electrolytic action which in time will destroy the joint. A remedy for this is to simply tape the joint so that it will be protected from the moisture.

J. Section insulators for sectionalizing the trolley circuit may be purchased in the market and they should be installed in such a manner as to prevent their wobbling when the trolley wheel passes under them. It is generally considered good practice to install a section insulator on a hanger. They may also be supported by hangers installed a short distance on each side of the insulater.

Section insulators are of three general kinds: the ordinary, automatic and hand operated. The ordinary type of section insulator is used where it is desired simply to sectionalize the trolley, as, for instance, in a case where one feeder would feed one section of trolley and another feed another section of trolley. There is no means provided for connecting the two sections of trolley together, except by the use of a jumper in an emergency.

The automatic section insulator is designed with a rocker arm so placed that the action of the trolley wheel in passing under the section insulator will cut in a section of trolley wire ahead of the locomotive. They have operated satisfactorily, but are open to the objection that they frequently get out of order and the movable parts give trouble.

The section insulator with switch is an ordinary section insulator with a knife switch placed on one side. The handle of the switch is brought out at an angle of about 45 degrees and is so placed that the locomotive driver in passing under the section insulator may throw the switch. It has the advantage of few working parts, very rugged construction and light weight.

K. In wiring entries where a grounded circuit is used, care should be taken to install the positive or hot wire next to the rib, with the negative or cold wire installed 10 inches on the outside of the hot wire.

No electrical conductors of any kind should be installed in mines unless they are put on suitable hangers or insulators. This, of course, would not apply to cases where conduit is used, for this latter condition is rather rare.

The installation of incandescent lamps in a mine should be done as thoroughly as that employed in house wiring. The practice of soldering a wire to the base of a lamp and hooking the other end across the circuit should be discontinued. Special precautions should be taken in gaseous mines to enclose all incandescent lamps in air-tight globes. The rules covering this will be found in the mining laws of the various states.

L. Whenever there is danger of the wires being touched, as, for example, when they cross an entry, they should be protected by trenching the roof or other suitable means. If trenches are used they should then be covered by one-inch boards fastened by wooden pegs or other means. The wires must not touch the roof but must be thoroughly insulated and well separated from it.

It should be understood that the above suggestions are for the average conditions encountered in a mine. Special conditions, of course, would require special treatment and cannot be covered here.

Note—In the preparation of this article liberal use has been made of Jackson's "Elementary Electricity and Magnetism," Burns' "Electrical Practice in Collieries," Black and Davis' "Practical Physics," "Practical Electricity," published by the Sears, Roebuck & Co., Ohio Brass Company Bulletins and other works on electricity. Our indebtedness to all of these, both as to text and illustrations, is gratefully acknowledged.

Inquiry Data for
Electric Motors.

a. Voltage.

b. Direct or alternating current. If latter, single, two or three phase and number of cycles per second. If direct current, shunt or compound wound.

c. Is motor to be directly coupled, back geared, or belted? Maximum speed of motor. Any idler equipment.

d. Controllers:
    - d-1 Any automatic control.
    - d-2 Any remote control.

e. Are motors open or enclosed or semi-enclosed types?

CURRENT FOR MOTORS.

Amperes for Each Lead at Full Load.

HORSE POWER.	DIRECT CURRENT.		ALTERNATING CURRENT.		
			PHASE		
			Single	Two	Three
	VOLTS		VOLTS		
	110	220	208	200	200
½	4.9	2.5	4.9	...	...
1	9	4.5	7.8	...	...
1½	13.6	6.8	...	...	...
2	18	9	15.9	...	...
3	25	13	21.5	...	...
5	42	21	32.5	12.9	14.9
7½	57	28	48	19	22
10	75	38	68	25	29
15	113	57	90	37	43
20	150	75	115	49	58
30	226	113	161	72	84
40	301	150	...	96	111
50	376	188	...	118	136
60	452	226	...	140	163
70	527	263	...	163	187
80	602	301	...	185	213
90	678	339	...	207	239
100	753	376	...	230	265

WIRING FORMULÆ.

$CM = \frac{22xLC}{V}$ Where load is at end of line.

$CM = \frac{11xLXC}{V}$ Where load is distributed along line.

CM = Circular mils.
L = Length in feet on one side of circuit.
C = Current in Amperes.
V = Loss in volts.

Equivalents of Electrical Units.

1 Kilowatt = 1000 Watts.
1 Kilowatt = 1.34 Horse power.
1 Kilowatt = 42257 Ft.-lbs. per min.
1 Kilowatt = 56.87 B. T. U. per min.
1 Horse power = 746 Watts.
1 Horse power = 33000 Ft.-lbs. per min.
1 Horse power = 42.41 B. T. U. per min.
1 B. T. U. = 778 Foot-pounds.
1 B. T. U. = 0.2930 Watt hours.

CARRYING CAPACITY OF INTERIOR CONDUCTORS

The question of drop is not taken into consideration in these tables.

The following table shows the allowable carrying capacity of wires and cables of 98 per cent. conductivity.

The lower limit is specified for rubber covered wires to prevent gradual deterioration of the insulation by the heat of the wires, but not from fear of igniting the insulation.—"N. B. of F. U."

Copper B. & S. Gauge.	Concealed Rubber-Covered Wires.	Exposed Weatherproof Wires.
	Amperes.	Amperes.
18	3	5
16	6	8
14	12	16
12	17	23
10	24	82
8	33	46
6	46	65
5	54	77
4	65	92
3	76	110
2	90	131
1	107	156
0	127	185
00	150	220
000	177	262
0000	210	312
Circular Mils.		
200,000	200	300
300,000	270	400
400,000	330	500
500,000	390	590
600,000	450	680
700,000	500	760
800,000	550	840
900,000	600	920
1,000,000	650	1,000
1,100,000	690	1,080
1,200,000	730	1,150
1,300,000	770	1,220
1,400,000	810	1,290
1,500,000	850	1,360
1,600,000	890	1,430
1,700,000	930	1,490
1,800,000	970	1,550
1,900,000	1,010	1,610
2,000,000	1,050	1,670

(Courtesy Hazard Manufacturing Company.)

OHMS LAW.

$C = \frac{E}{R}$ $R = \frac{E}{C}$ $E = CR$

$W = EC = C^2R = \frac{R}{E^2}$

$H.P. = \frac{EC}{746} = \frac{C^2R}{746} = \frac{E^2}{R \times 746} = \frac{W}{746}$

E = Electromotiv force in volts.
R = Resistance in Ohms.
C = Current in Amperes.
W = Power in Watts.
H.P. = Horse-power.

Courtesy Randolph-Means Co.

Alternating Current Formulae.

$C = \frac{W}{E \times P.F.}$ For single phase.

$C = 0.50 \times \frac{W}{E \times P.F}$ For two phase.

$C = 0.58 \times \frac{W}{E \times P.F}$ For three phase.

C = Current in line in Amperes.
W = Energy delivered in Watts.
E = Volts between mains.
P. F. = Power Factor. When power factor cannot be accurately determined it may be assumed as follows: Lighting load only .95; lighting load and motors .85; motors only .80.

Kilowatts and Horsepower

0.746 Kilowatts = 1 Horsepower

Kilowatts to Horse power				Horsepower to Kilowatts			
Kw.	Horsepower	Kw.	Horsepower	Hp.	Kilowatts	Hp.	Kilowatts
1	1.341	55	73.733	1	.746	55	41.03
2	2.681	60	80.436	2	1.492	60	44.76
3	4.022	65	87.139	3	2.238	65	48.49
4	5.363	70	93.842	4	2.984	70	52.22
5	6.703	75	100.545	5	3.730	75	55.95
6	8.044	80	107.248	6	4.476	80	59.68
7	9.384	85	113.951	7	5.222	85	63.41
8	10.725	90	120.654	8	5.968	90	67.14
9	12.065	95	127.357	9	6.714	95	70.87
10	13.406	100	134.048	10	7.460	100	74.60
11	14.747	110	147.47	11	8.206	110	82.06
12	16.087	120	160.87	12	8.952	120	89.52
13	17.428	130	174.28	13	9.698	130	96.98
14	18.768	140	187.68	14	10.444	140	104.44
15	20.109	150	201.09	15	11.190	150	111.90
16	21.450	160	214.50	16	11.936	160	119.36
17	22.790	170	227.90	17	12.682	170	126.82
18	24.131	180	241 31	18	13.428	180	134.28
19	25.471	190	254.71	19	14.174	190	141.74
20	26.812	200	268.12	20	14.920	200	149.20
22	29.493	220	294.93	22	16.412	220	164.12
24	32 174	240	321.74	24	17.904	240	179.04
26	34.856	260	348.56	26	19.396	260	193.96
28	37.537	280	375.37	28	20.888	280	208.88
30	40.218	300	402.18	30	22.380	300	223.80
32	42.899	325	435 69	32	23.872	325	242.45
34	45 580	350	469.21	34	25.364	350	261.1
36	48.261	400	536.24	36	26.856	400	298.4
38	50.943	450	603.27	38	28.348	450	335.7
40	53.624	500	670.30	40	29.840	500	373.0
42	56.305	600	804.36	42	31.332	600	447.6
44	58.986	700	938.42	44	32.824	700	522.2
46	61.667	800	1072 48	46	34.316	800	596.8
48	64.349	900	1206.54	48	35.808	900	671.4
50	67.030	1000	1340.60	50	37.300	1000	746.0

Courtesy Goodman Mfg. Co.

Speed and Frequency Table

For A. C. Apparatus

Frequency	125 Cycles	60 Cycles	50 Cycles	40 Cycles	30 Cycles	25 Cycles
Alt. per Min.	15000	7200	6000	4800	3600	3000
POLES			SPEED			
2	7500	3600	3000	2400	1800	1500
4	3750	1800	1500	1200	900	750
6	2500	1200	1000	800	600	500
8	1875	900	750	600	450	375
10	1500	720	600	480	360	300
12	1250	600	500	400	300	250
14	1071	514	428	343	257	214
16	937½	450	375	300	225	187½
18	833⅓	400	333	266	200	167
20	750	360	300	240	180	150
22	682	327	273	218	164	136
24	625	300	250	200	150	125
26	577	277	231	185	138	115
28	536	257	214	173	129	107
30	500	240	200	160	120	100
32	469	225	187	150	113	94
34	441	212	177	141	106	88½
36	417	200	167	133	100	83⅓
38	395	189½	158	126	95	79
40	375	180	150	120	90	75
42	357	171	143	114	86	
44	341	163½	136	109	82	
46	326	156½	130	104	78	
48	312½	150	125	100		
50	300	144	120	96		
52	288	138½	115	92½		
54	277½	133⅓	111	89		
56	268	128½	107	86		
58	258½	124	103	83		
60	250	120	100	80		
62	242	116	97			
64	234⅓	112½	94			
66	227	109	91			
68	220½	106	88½			
70	214	103	86			
72	208⅓	100	83			
74	202½	97½	81			
76	197½	95				
78	192	92½				
80	187½	90				
82	183	88				
84	178½	86				
86	174½	84				
88	170½	82				
90	166⅔	80				
92	163	78				
94	159½	76½				
96	156	75				
98	153					
100	150					

Courtesy Crocker-Wheeler Co.

TABLES
METRIC SYSTEM OF WEIGHTS AND MEASURES

Measures of Lengths

1 Millimeter = 0 001 Meter = 0.0394 Inch.
1 Centimeter = 0.01 Meter = 0.3937 Inch.
1 Decimeter = 0.1 Meter = 3.937 Inches.
1 Meter = 1 Meter = 39 37 Inches.
1 Dekameter = 10 Meters = 393.7 Inches.
1 Hectometer = 100 Meters = 328 Feet, 1 Inch.
1 Kilometer = 1000 Meters = 3280 Feet, 10 Inches.
1 Myriameter = 10000 Meters = 6.2137 Miles

It will be noticed that 10 Millimeters equal 1 Centimeter, 10 Centimeters equal 1 Decimeter, and so on.

Measures of Volumes

1 Milliliter = 0.001 Liter = 0.061 Cubic Inch.
1 Centiliter = 0.01 Liter = 0.6102 Cubic Inch.
1 Deciliter = 0.1 Liter = 6.1022 Cubic Inches.
1 Liter = 1 Liter = 0.9081 Quart.
1 Dekaliter = 10. Liters = 9.081 Quarts.
1 Hectoliter = 100. Liters = 2 Bushels, 3 35 Pecks.
1 Kiloliter = 1000 Liters = 1.308 Cubic Yards.

Weights

1 Milligramme = 0 001 Gramme = 0.0154 Grain.
1 Centigramme = 0 01 Gramme = 0.1543 Grain.
1 Decigramme = 0 1 Gramme = 1.5432 Grains.
1 Gramme = 1 Gramme = 15.432 Grains.
1 Dekagramme = 10 Grammes = 0.3527 Ounce.
1 Hectogramme = 100. Grammes = 3.5274 Ounces.
1 Kilogramme = 1000. Grammes = 2.2046 Pounds.
1 Myriagramme = 10000 Grammes = 22.046 Pounds.

Metric and English Equivalents

Inches = Millimeters ÷ 25 4
Feet = Meters x 3.28083
Yards = Meters x 1.09364
Miles = Kilometers ÷ 1 60935
Sq. In. = Square Millimeters x 00155
Sq. Ft. = Square Meters x 10.7641
Acres = Square Kilometers x 247 114
Cu. In. = Cubic Centimeters ÷ 16.3870
Cu. Ft. = Cubic Meters x 35.3140

Lbs. Avoirdupois = Kilogrammes x 2.20463
Tons (2000 lbs.) = Kilogrammes ÷ 907.18
Lbs. per Foot = Kilo. per Meter x .67196
Lbs. per Cu. Ft. = Kilo. per Cu. Meter x .06243
Sq. Millimeters = Square Inches x 645.137
Sq. Meter = Square Feet x .0929
Grammes = Ounces x 28.3495
Grammes = Pounds x 453.5926
Kilogrammes = Pounds x .45359

ELECTRICAL PROPERTIES OF MINE TRACKS

Weights of Rail per yd.	Equivalent Area in Cir. Mils of Copper	Resistance at 24°C.		Loss in Volts per Amp. in 100 ft. Track	Safe Amp. 10°C. Rise.
		Ohms per	Ohms per 1000 ft.		
16	320000	.1737	.0329	.0033	500
20	400000	.1684	.0263	.0026	600
25	500000	.1109	.0210	.0021	675
30	600000	.0924	.0175	.0017	750
35	700000	.0792	.0150	.0015	850
40	800000	.0692	.0131	.0013	950
45	900000	.0616	.0117	.0012	1050
50	1000000	.0554	.0105	.0011	1150
55	1100000	.0504	.0095	.0010	1250
60	1200000	.0464	.0088	.0009	1300
65	1300000	.0417	.0079	.0008	1400
70	1400000	.0396	.0075	.00075	1500
80	1600000	.0345	.0065	.00065	1700
90	1800000	.0307	.0058	.00058	1900
100	2000000	.0270	.0051	.00051	2150

Calculated by Alex. Palmros Dec. '07.

Volts Lost with Various Copper Wire Combinations

Sizes of Wires	Area, Circular Mils.	Weight of Combination, Pounds per 1000 feet.	Volts Lost per Ampere per 1000 feet.
One No. 0000 and One No. 000	379405	1149	0 027
" " " " " 00	344679	1044	030
" " " " " 0	317192	960	.033
" " " " " 1	295295	894	035
One No. 0000 and Two No. 000	547210	1657	019
" " " " " 00	477758	1447	022
" " " " " 0	422784	1280	.025
" " " " " 1	378990	1148	027
One No. 000 and One No. 00	300884	911	035
" " " " " 0	.273397	828	.038
" " " " " 1	251500	762	041
One No. 000 and Two No. 00	433963	1314	.024
" " " " " 0	378989	1147	.027
" " " " " 1	335195	1015	.031
One No. 00 and One No. 0	238671	723	.043
" " " " " 1	216774	656	.048
One No. 00 and Two No. 0	344263	1042	.030
" " " " " " 1	300469	910	.035
One No. 0 and One No. 1	189287	573	.055
One No. 0 and Two No. 1	272982	827	.038

Formulas for Transmission Line Calculations

These formulas, and the tables of Constants on the following page are based upon a spacing of 18 inches for the wires, and results are sufficiently accurate for practical purposes with wires approximately that distance apart. Capacity has been neglected.

ALTERNATING CURRENT:

Area of conductor, circular mils $= \dfrac{D \times W \times K}{P \times E^2}$

Current in each conductor, amperes $= \dfrac{W \times T}{E}$

Loss in lines, volts $= \dfrac{P \times E \times M}{100}$

Weight of Copper, pounds $= \dfrac{D^2 \times W \times K \times A}{P \times E^2 \times 1{,}000{,}000}$

Wherein:

A = Constant (See table, opposite page)
D = Distance of transmission, one way, in feet.
E = Voltage between main conductors at receiving or consumer's end of circuit.
K For any power factor = 2160 divided by the square of that power factor, for single phase.
= 2160 divided by twice the square of that power factor, for 2-phase, 4-wire and 3-phase, 3-wire.
M = Constant (See table, next page).
P = Loss in line, in percentage of power (W) delivered to consumer.
T = Constant (See table, opposite page)
W = Total watts delivered to consumer.

Power factors for balanced circuits—

Single phase: $\dfrac{\text{Actual watts delivered.}}{\text{Volts} \times \text{Amperes}}$

2-phase, 4-wire: $\dfrac{\text{Actual Watts, Total.}}{2 \times \text{Volts} \times \text{Amperes (per phase)}}$

3-phase, 3-wire: $\dfrac{\text{Actual Watts, Total.}}{1.73\ \text{Volts} \times \text{Amperes (per phase)}}$

FOR DIRECT CURRENT: A = 6.04, K = 2160, M = 1, T = 1.

Volts Drop in Bonded Track

Losses Per Ampere per 1,000 Feet of Single Track

Rail Bonds of No. 1 Copper Wire

Weight of Rail, Pounds per Yard	Length of Bond, Feet	Volts Drop per Ampere per 1000 feet of Single Track			
		30-Ft. Rail Lengths		20-Ft. Rail Lengths	
		Single Bonded	Double Bonded	Single Bonded	Double Bonded
8	2½	0 0344	0.0318	0 0354	0.0317
12	2½	.0247	0221	0261	.0224
16	2½	0198	0172	0214	0176
20	2½	.0168	0142	.0188	0149
25	2½	.0145	0119	.0166	.0126
30	2½	0139	0108	.0165	.0120
35	3	.0128	0097	.0155	.0109
40	3	0120	0089	0148	.0101
45	3	.0114	.0083	.0142	.0096
50	3	0109	0078	0137	.0090
55	3	.0104	0073	0133	.0086
60	3	.0101	.0070	.0129	.0083
65	3	0098	.0067	.0126	.0080
70	3	.0095	.0064	.0124	.0077

Constants for
Transmission Line Calculations

Phases	Wires	Values of A	Values of K				Values of T			
			Per Cent Power Factor				Per Cent Power Factor			
			100	95	85	80	100	95	85	80
1		6.04	2160	2400	3000	3380	1.00	1.05	1.17	1.25
2	4	12.08	1080	1200	1500	1690	.50	.53	59	.62
3	3	9.06	1080	1200	1500	1690	58	61	.68	72

Wire No., B. & S. Gauge	Values of M							
	25 Cycles				60 Cycles			
	Per Cent Power Factor				Per Cent Power Factor			
	95	90	85	80	95	90	85	80
0000	1.23	1.29	1.33	1.34	1.62	1.84	1.99	2.09
000	1.18	1.22	1.24	1.24	1.49	1.66	1.77	1.95
00	1.14	1.16	1 16	1 16	1.34	1.52	1.60	1.66
0	1.10	1.11	1.10	1.09	1.31	1.40	1.46	1.49
1	1.07	1.07	1.05	1.03	1.24	1.30	1.34	1.36
2	1 05	1.04	1 02	1 00	1.18	1 23	1.25	1.26
3	1.03	1.02	1 00	1.00	1.14	1.17	1.18	1.17
4	1.02	1.00	1 00	1.00	1.11	1.12	1.11	1.10
5	1.00	1 00	1.00	1.00	1.08	1.08	1.06	1.04
6	1.00	1 00	1.00	1.00	1.05	1.04	1.02	1.00
7	1.00	1.00	1.00	1.00	1.03	1.02	1.00	1.00
8	1.00	1 00	1 00	1.00	1.02	1.00	1.00	1.00
9	1 00	1 00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Properties of

Stranded Copper and Aluminum Cable

at 75° Fahrenheit

Conductivity: Copper 98%; Aluminum 62%

Wire No., .&S. auge	Area, Circular Mils	Copper			Aluminum		
		Weight of Bare Cable, Pounds		Volts Lost per Ampere per 1000 Feet	Weight of Bare Cable, Pounds		Volts Lost per Ampere per 1000 Feet
		Per 1000 Feet	Per Mile		Per 1000 Feet	Per Mile	
	1000000	3050	16104	0.0105	920	4858	0.0166
	950000	2898	15299	.0111	874	4617	.0175
	900000	2745	14494	.0117	828	4374	.0185
	850000	2593	13688	.0124	782	4131	.0196
	800000	2440	12883	.0131	736	3888	.0207
	750000	2288	12078	.0140	690	3645	.0221
	700000	2135	11273	.0150	644	3402	.0237
	650000	1983	10468	.0162	598	3159	.0256
	600000	1830	9662	.0175	552	2916	.0276
	550000	1678	8857	.0191	506	2673	.0302
	500000	1525	8052	.0210	460	2430	.0332
	450000	1373	7247	0234	414	2187	0370
	400000	1220	6442	.0263	368	1944	.0416
	350000	1068	5636	.0300	322	1701	.0474
	300000	915	4831	.0350	276	1458	.0553
	250000	762	4026	0420	230	1215	0664
0000	211600	645	3405	.0497	194.7	1028	.0785
000	167805	513	2709	.0625	154.4	816	.0987
00	133079	406	2144	.0789	122.4	647	1247
0	105592	322	1700	0995	97.1	513	1573
1	83695	255	1346	.1258	77.0	407	1988
2	66373	203	1072	.1579	61.0	323	.2495
3	52634	160	845	.2004	48.5	256	3168
4	41743	127	671	2525	38.5	203	3990
5	33102	103	544	.3112	30.2	161	.4920
6	26251	81	428	.3960	24.1	128	.6260

Breaking Strain of

Copper and Aluminum Wire and Cable

Ultimate strength of Annealed Copper taken at 34,000 pounds per square inch.

Ultimate strength of Hard Drawn Copper taken at 60,000 pounds per square inch, except: 50,000 pounds for Nos. 0000, 000 and 00, 55,000 pounds for No. 0; 57,000 pounds for No. 1.

Ultimate strength of Aluminum taken at 26,000 pounds per square inch.

Table gives actual breaking strains, to which a suitable safety factor must be applied to secure proper working strengths.

Wire No., B. & S. Gauge	Area, Circular Mils	Breaking Strain, Pounds			
		Copper, Solid		Aluminum	
		Annealed	Hard Drawn	Solid	Stranded
	1000000	.....	.....	20420	32280
	900000	.....	.....	18380	29050
	800000	.....	.....	16340	25820
	700000	.....	.....	14300	22590
	600000	.....	.....	12250	19370
	500000	.....	.....	10210	16140
	400000	.....	.....	8170	12910
	300000	.....	.....	6130	9680
	250000	.....	.....	5110	8070
0000	211600	5650	8310	4320	6830
000	167805	4475	6580	3430	5420
00	133079	3550	5226	2720	4290
0	105592	2800	4558	2150	3410
1	83695	2225	3746	1710	2700
2	66373	1775	3127	1355	2143
3	52634	1400	2480	1075	1700
4	41743	1115	1967	852	1350
5	33102	885	1519	657	1070
6	26251	700	1237	536	850
7	20817	550	980	426	.....
8	16510	440	778	337	.....
9	13094	350	617	267	.....
10	10382	275	489	212	.....
11	8234	220	388	167	.....
12	6230	175	307	133	.....
13	5178	135	244	105	.....
14	4107	110	193	84	.....

Weight of

Bare Copper Wire

Wire No., B. & S. Gauge	Diameter, Inches	Area, Circular Mils	Weight of Bare Wire, Pounds	
			Per 1000 Feet	Per Mile
0000	0.460	211600	640.7	3383
000	.410	167805	508.1	2683
00	365	133079	403.0	2128'
0	325	105592	319.7	1688
1	.289	83695	253.4	1338
2	.258	66373	201.0	1061
3	.229	52634	159.4	841.5
4	204	41743	126.4	667.4
5	.182	33102	100.2	529.2
6	.162	26251	79.5	419.7
7	144	20817	63.0	332.8
8	.129	16510	50.0	264.0
9	.114	13094	39.7	209.4
10	.102	10382	31.4	166.0
11	.091	8234	24.9	131.7
12	.081	6230	19.8	104.4
13	.072	5178	15.7	82.8
14	.064	4107	12.4	65.7
15	.057	3257	9.86	52.07
16	.051	2583	7.82	41.29
17	.045	2048	6.20	32.75
18	.040	1624	4.92	25.97
19	.036	1288	3.90	20.59
20	032	1021	3.09	16.33
21	.029	810.1	2.45	12.95
22	.025	642.5	1.95	10.27
23	.023	509.5	1.54	8.15
24	.020	404.0	1.22	6.46
25	.018	320.4	.97	5.12
26	.016	254.1	.77	4.06

Resistance of

Copper and Aluminum Wire

at 75° Fahrenheit

Conductivity: Copper 98%; Aluminum 62%.

Wire No., B.&S. Gauge	Area, Circular Mils	Copper			Aluminum		
		Volts Lost per Ampere		Feet per Ohm	Volts Lost per Ampere		Feet per Ohm
		Per 1000 Feet	Per Mile		Per 1000 Feet	Per Mile	
0000	211600	0.049	0.259	20393	0.078	0.410	12888.9
000	167805	.062	.327	16172	.098	.517	10236.9
00	133079	.078	.412	12825	.123	.652	8118.5
0	105592	.098	.519	10176	.155	.822	6441.7
1	83695	.124	.655	8066	.196	1.036	5105.8
2	66373	.156	.825	6396.7	.247	1.306	4049.1
3	52634	.197	1.04	5072.5	.311	1.646	2546.5
4	41743	.249	1.31	4022.9	.393	2.075	3210.9
5	33102	.314	1.66	3190.2	.496	2.620	2019.4
6	26251	.395	2.09	2529.9	625	3.305	1601.4
7	20817	.499	2.63	2006.2	.789	4.173	1269.9
8	16510	.629	3.32	1591.1	.994	5.255	1007.2
9	13094	.792	4.18	1262.0	1.253	6.627	798.8
10	10382	1.00	5.28	1000.5	1.580	8.360	633.3
11	8234	1.26	6.65	793.6	1.990	10.53	502.32
12	6230	1.59	8.39	629.3	2.513	13.29	398.35
13	5178	2.00	10.58	499.1	3.167	16.75	315.90
14	4107	2.53	13.34	395.8	3.992	21.10	250.54
15	3257	3.19	16.82	313.9	5.035	26.66	198.68
16	2583	4.02	21.21	248.9	6.345	33.55	157.55
17	2048	5.07	26.75	197.4	8.013	42.30	124.95
18	1624	6.39	33.73	156.5	10.11	53.40	99.09
19	1288	8.06	42.53	124.1	12.73	67.25	78.58
20	1021	10.16	53.64	98.44	16.07	85.06	62.31
21	810.1	12.81	67.63	78.07	20.25	107.1	49.42
22	642.5	16.15	85.27	61.92	25.53	134.9	39.20
23	509.5	20.37	107.5	49.10	32.20	170.3	31.08
24	404.0	25.68	135.6	38.94	40.65	214.8	24.65
25	320.4	32.38	171.0	30.88	51.23	271.0	19.55
26	254.1	40.84	215.6	24.49	64.65	341.8	15 50

Courtesy Goodman Mfg. Co.

Diameter and Weight of

Standard Weatherproof Insulated Copper Wire and Cable

Triple Braid

Wire No., B. & S. Gauge	Area, Circular Mils	Solid		Stranded	
		Diameter, Inches	Weight, Pounds per 1000 Feet	Diameter Inches	Weight, Pounds per 1000 Feet
	1000000	....	....	1.45	3674
	900000	....	....	1.39	3332
	800000	....	....	1 33	2992
	700000	....	....	1.27	2650
	600000	....	....	1.19	2235
	500000	....	....	1.11	1894
	400000	....	....	1.02	1553
	300000	....	....	.93	1174
0000	211600	0.66	767	.79	800
000	167805	.60	629	.73	653
00	133079	.55	502	66	522
0	105592	.51	407	61	424
1	83695	.45	316	.52	328
2	66373	.40	260	.44	270
3	52634	.37	208	.41	219
4	41743	.35	164	.38	170
5	33102	.32	130	.35	146
6	26251	.30	112	.33	115

Diameter and Weight of

Rubber Insulated Copper Wire and Cable

National Electric Code Standard. 0 to 600 Volts

Triple Braid

Wire No. B. & S. Gauge	Area, Circular Mils	Solid		Stranded	
		Diameter, Inches	Weight, Pounds per 1000 Feet	Diameter, Inches	Weight, Pounds per 1000 Feet
	1000000	....	....	1.54	3637
	900000	....	....	1.48	3304
	800000	....	....	1.42	2968
	700000	....	....	1.35	2631
	600000	....	....	1.28	2290
	500000	....	....	1.17	1906
	400000	....	....	1.09	1573
	300000	....	....	.99	1226
0000	211600	0.78	835	.85	879
000	167805	.73	685	.79	719
00	133079	.69	564	.74	595
0	105592	.65	474	.70	494
1	83695	.61	395	.66	412
2	66373	.51	297	.59	324
3	52634	.48	247	.52	260
4	41743	.46	208	.49	218
5	33102	.41	167	.46	184
6	26251	.39	142	.41	149

·Courtesy Goodman Mfg. Co.

Diameter and Weight of

Standard Weatherproof Insulated Copper Wire and Cable

Double Braid

Wire No., B. & S. Gauge	Area, Circular Mils	Solid		Stranded	
		Diameter, Inches	Weight, Pounds per 1000 Feet	Diameter, Inches	Weight, Pounds per 1000 Feet
	1000000	....	....	1.37	3456
	900000	....	....	1.31	3127
	800000	....	....	1.24	2799
	700000	....	....	1.18	2471
	600000	....	....	1.11	2093
	500000	....	....	1.03	1765
	400000	....	....	.94	1436
	300000	....	....	.85	1083
0000	211600	0.61	723	.71	745
000	167805	56	587	.65	604
00	133079	.52	467	.60	482
0	105592	.47	377	.56	388
1	83695	.41	294	.47	303
2	66373	.37	239	.42	246
3	52634	.35	185	.38	190
4	41743	.32	151	.35	155
5	33102	30	122	32	126
6	26251	.28	100	.31	103

Diameter and Weight of

Rubber Insulated Copper Wire and Cable

National Electric Code Standard. 0 to 600 Volts

Double Braid

Wire No. B. & S. Gauge	Area, Circular Mils	Solid		Stranded	
		Diameter, Inches	Weight, Pounds per 1000 Feet	Diameter, Inches	Weight, Pounds per 1000 Feet
	1000900	....	....	1.46	3553
	900000	....	....	1.40	3223
	800000	....	....	1.33	2891
	700000	....	....	1.27	2557
	600000	....	....	1.19	2220
	500000	....	....	1.09	1842
	400000	....	....	1.00	1514
	300000	....	....	.90	1173
0000	211600	0.70	793	.77	833
000	167805	.65	646	.71	675
00	133079	.61	528	.66	556
0	105592	.57	439	.61	457
1	83695	.53	363	.57	37.7
2	66373	.45	276	.50	293
3	52634	.42	228	.45	238
4	41743	.39	190	.42	198
5	33102	.36	154	.40	166
6	26251	.34	130	.36	136
7	20817	.30	105	.32	108
8	16510	.27	82.1	.29	85 5
9	13094	.26	68.4	.27	70 0
10	10382	.25	58.1	.26	60 6
11	8234	.24	50.0	.25	52 3
12	6230	.23	43.1	24	44 9
13	5178	.22	38.5	.23	39 6
14	4107	.21	33.0	.22	34.3

AMERICAN STEEL & WIRE CO.

Sales Offices

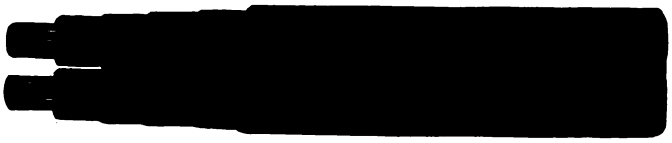
CHICAGO	208 So. La Salle Street
NEW YORK	30 Church Street
WORCESTER	94 Grove Street
BOSTON	120 Franklin Street
PHILADELPHIA	Widener Building
PITTSBURGH	Frick Building
BUFFALO	337 Washington Street
DETROIT	Foot of First Street
CINCINNATI	Union Trust Building
CLEVELAND	Western Reserve Building
BALTIMORE	32 So. Charles Street
WILKESBARRE, PA	Miners Bank Building
ST. LOUIS	3d National Bank Building
ST. PAUL-MINNEAPOLIS	Pioneer Bldg., St. Paul
OKLAHOMA CITY	State National Bank Building
BIRMINGHAM, ALA	Brown-Marx Building
DENVER	1st National Bank Building
SALT LAKE CITY	Walker Bank Building

Export Representative: U. S. Steel Products Co., New York
Pacific Coast Representative: U S. Steel Products Company
San Francisco Los Angeles Portland Seattle

ELECTRICAL WIRES

Americore Rubber Covered Wire.

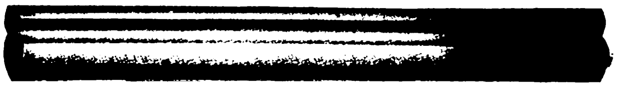
Solid Conductor Rubber Covered Lead Encased Wire.



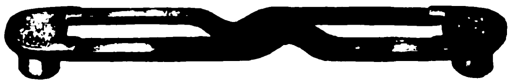
Duplex Parallel Mining Machine Cable.

Concentric Mining Machine Cable.

Reliance Weatherproof Cables.



Copper Trolley Wire.



United States Rail Bond.

Products

We manufacture bare copper wires and cables for telephone, telegraph and power transmission purposes; also insulated wires of all kinds such as weatherproof wires and cables, magnet, annunciator and office wire, lamp cord, sub-marine cables, car wires, together with all kinds of rubber covered wires and lead encased cables for interior and exterior purposes. Our mining machine cables are made with special strong braids which withstands abrasion to advantage. We also make them in a hard spun cotton braid when the usage is extra severe.

Stocks

Are carried with jobbers and dealers in all mining communities also in our warehouses at Chicago, New York, Pittsburgh, Buffalo, Cleveland and St. Louis.

D & W FUSE COMPANY

PROVIDENCE, RHODE ISLAND

Deltabeston Wires

Prevent burnouts. Asbestos will not carbonize. Does not deteriorate. Heat-proof. Moisture-proof. Maintenance cost eliminated.

Round Magnet Wire

Covered with pure asbestos fibre in a smooth flexible mass, which will not crack or break, even when sharp bends are made. Tough, moisture-proof and indestructible under any commercial temperature.

Flat Magnet Wire

Made in a great range of sizes for bigger cross-section of copper. Its prepared asbestos, fire-proof insulation is tenacious and adheres to flat sides and rounded corners of wires, even when bent or twisted.

Fixture Wire

For installations where temperature makes rubber covered wires impracticable, this smooth, flexible, tenacious asbestos covering will give best protection and longest service.

Fixture Wire

Same construction as the above, with the addition of a silk covering over the asbestos fibre to give a neat, attractive appearance where wiring of fixtures is exposed to view. Made in single, parallel and twisted conductors.

Stove Wire

Furnishes perfect wiring for electric stoves and ranges, in and around oven and boiler rooms. Insulated with especially treated asbestos fibre and tightly braided asbestos covering.

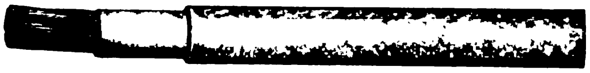
Heater Cord

Asbestos insulated throughout; will not burn nor deteriorate like rubber. The stranded conductors are cemented together so that should some of them break they will not penetrate the wall and cause short circuit.

Switchboard Wire

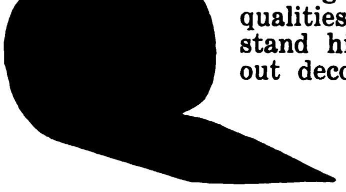
Over the asbestos fibre wall, filled with moisture-proof compound, is braided an asbestos cover in either black or white finish. Being fireproof, it is decidedly better for switchboards than the "slow burning" wires commonly used.

Moving Picture Cable



A very flexible conductor having a wall of asbestos fibre and a braided asbestos covering; moisture-proof; widely used where wires are subjected to high temperatures—projectors, searchlights, railroad controllers, cranes, etc.

Deltatape



A heat resisting insulating material having asbestos fibre as a base. Combines good electrical insulating qualities with ability to withstand high temperatures without decomposition. Flexibility and tenacity insures facility in manipulation. Particularly adapted for insulating ribbon wound coils, for slot insulation and the like.

Write for Deltabeston Catalog No. 5 K and sample card.

Approved by the Underwriters' Laboratories, Inc.

HAZARD MFG COMPANY

WILKES-BARRE, PA.

NEW YORK
533 Canal Street

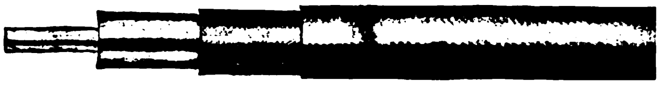
PITTSBURGH
1st Nat'l Bank Building

CHICAGO
522 W. Adams Street

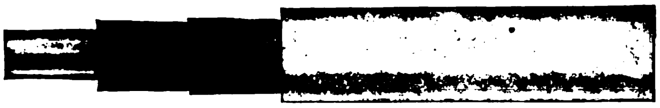
INSULATED WIRES AND CABLES

Products

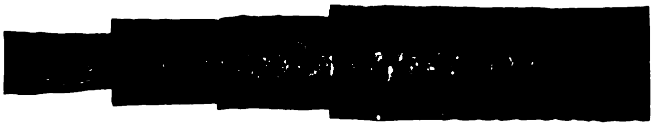
Bare and Insulated Wires and Cables for Light and Power Transmission, Telephone, Telegraph, Signals, Mining Machines and Electric Locomotives.



8-B. & S. Solid, Rubber Insulation, Two Braids.



2-B. & S. Solid, Rubber Insulation, Tape and Lead.



3-B. & S. Extra Flexible Locomotive Reel Cable.

Rubber Covered Wires and Cables

For Light, Power, Telephone, Telegraph, Signals, Mining Machines and Electric Locomotives.

Circular Loom Covered Cables

For use in locations where especially severe conditions of moisture or abrasion are encountered.

Weatherproof Wires and Cables

For Light and Power Transmission.

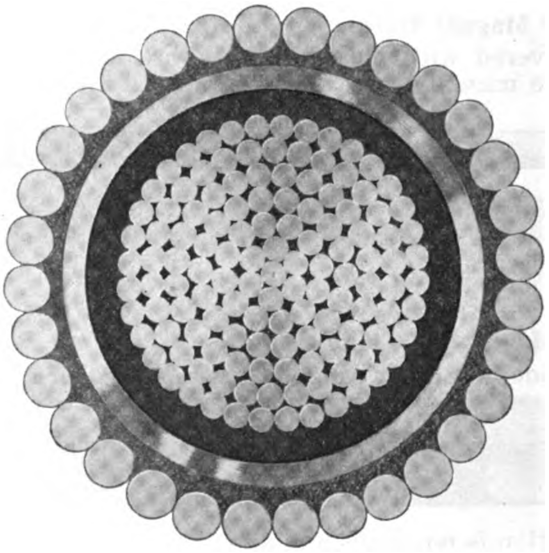
Bare Copper Wires and Cables

For Telephone and Power Transmission.

Mining Machine Cables

Made in Twin flat form or Concentric round form. The Twin flat form Cables are made with two flexible copper conductors, each covered with rubber and one cotton braid. Over these are placed two or three cotton braids and the whole is thoroughly saturated with a weatherproofing compound.

The Concentric round form cables are made with one flexible copper conductor in the center covered with rubber and tape. Over this is placed a layer of fine copper wires equivalent to the copper conductor in the center and this in turn is covered with a layer of rubber and finished with two or three cotton braids thoroughly saturated with a weatherproofing compound. Hazard Hard Service Braids recommended. Description next column.



2,000,000 C. M. Power Cable. Rubber, Lead & Armor.

Locomotive Reel Cables

Are made with a flexible copper conductor covered with rubber and finished with two or three cotton braids thoroughly saturated with a weatherproofing compound. Particular attention is paid to the finish of these cables so that they will be able to withstand the severe conditions to which they must be subjected. The outer covering may be Hazard Hard Service Braid, a braid particularly adapted to withstand the sharp cutting edges of fresh mined coal. These outer coverings are put on in such a way that they do not become loose on the rubber and pile up when running through the guides, thus stopping the reel and allowing the locomotive to run over and cut the cable. This feature tends to reduce the cost of locomotive operation.

Hazard Hard Service Braids

These braids are designed to minimize the wear on the outer coverings of portable conductors. This special hard and tough covering greatly increases the life of Mining Machine and Locomotive Cables and may be had for a slight increase of first cost.

Armored Cables

Cables for power transmission down shafts and bore holes are made to meet requirements. They may be made with protecting coverings of rubber, lead, steel armor and tarred jute. Cables thus made may be suspended in shafts and bore holes and be protected from the destructive influences of acid waters.

JOHN A. ROEBLING'S SONS CO.

TRENTON, N. J.

CHICAGO, PHILADELPHIA, PITTSBURGH, CLEVELAND, ATLANTA,
John A. Roebling's Sons Co., of New York, New York.
John A. Roebling's Sons Co., of California.
SAN FRANCISCO, LOS ANGELES, SEATTLE, PORTLAND, ORE.

MANUFACTURERS OF

WIRE

Products

Roebling wires include iron, steel and copper wire in round, flat and special shapes. Wire for mine telephones and every kind of wire or cable needed in the electrical equipment of mines is made at the Roebling works with careful attention given to materials and workmanship.

Mining Machine Cables, Duplex

Duplex mining machine cables are made with flexible strands. The rubber insulation is N. E. C. S. thickness. Each conductor is furnished with a weatherproof braid, then laid side by side and covered with two or three braids of hard heavy cotton finished with a weatherproof compound.

Mining Machine Cables, Concentric Construction "A"

This type of cable has a flexible strand insulated with rubber 1-64″ thicker than N. E. C. S. This center is covered with a tape and braid. Fine wires are placed over the covered center, the area of the wires being equal to that of the center conductor.

A belt of rubber 1-64″ less than that on the inner conductor is then applied and the whole cable finished with a tape and a heavy double braid, weatherproofed.

Concentric Construction "B"

This is the same as construction "A" but without the outside belt of rubber.

Locomotive Cable

Locomotive cables are used to conduct current to electric locomotives in mines where the track extends beyond the trolley wire. The conductor is flexible with N. E. C. S. thickness of rubber insulation over which there are two extra heavy tough weatherproof braids.

Fireproof Wire

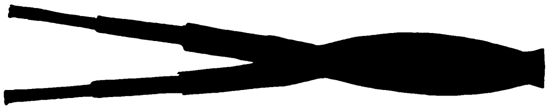
The strand of fireproof wire is flexible. The insulation is a braid of cotton, specially treated, and a finishing braid of asbestos. Both braids are heavily impregnated with our special fireproof paint.

Slow Burning Wire

The conductor of slow burning wire may be solid, stranded or flexible. The insulation is three braids of cotton thoroughly impregnated with our special fireproof paint.

Magnet Wire

We carry in stock at our works and branch warehouses a full stock of magnet wire. This includes single and double cotton covered, single and double silk covered, asbestos and single cotton covered, enameled wire, enameled and single silk and enameled and single cotton covered wires.



Brewery Cord

This cord has weather proof braids on each conductor making it suitable in all damp places for incandescent lighting.

Standard Underground Cable Co.

PITTSBURGH, PA.

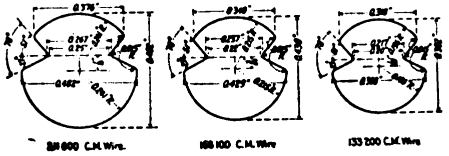
Boston New York Philadelphia Pittsburgh St. Louis Chicago San Francisco
and other principal cities.

Products

Copper and Brass Rods, Wires, Tubes; Colonial Copper Clad Steel Wire; Weatherproof and Magnet Wire; Special Mining Cables of all kinds; Rubber Insulated Wires; Lead Covered Cables; Steel-Wire and Steel-Tape Armored Cables; Cable Terminals, etc.

Over 35 years devoted exclusively to the manufacture of electric wires and cables, together with special study of the requirements of mining service, enable us to offer high grade products that will give durable and economical service.

Bare Copper Wire and Cable



Trolley Wire (Hard Drawn)—Round, grooved, or figure 8.

Transmission Wire—Solid or stranded, hard, medium or soft.

Bonding Wire—Soft drawn (annealed).

Magnet Wire

Round, square and rectangular shapes. Insulated with asbestos, cotton or silk.

Mining Machine Cables.

Flat Duplex—Two flexible conductors, each insulated with rubber and braid, and with two or three tough protecting braids over all.

Concentrix Duplex—Construction A—Flexible inner conductor, rubber insulated and braided, outer conductor laid thereover, with rubber insulation and two tough protecting braids over all.

"Wearproof"—Furnished in any number of conductors, but usually in duplex cable in one of the two following styles:

(1) Flexible conductors separately rubber insulated and braided, twisted together, and further protected with one or more saturated braids and a spirally wound steel armor.

(2) Concentric Duplex, same as Construction A, except with the additional protection of a spirally wound steel armor.

"Wearproof" Cable is strong, durable, withstands abrasion, does not kink, and increases cable life.

Gathering Locomotive Cable

Flexible conductor, rubber insulated and protected by one or more tough braids. This cable is flexible, strong and durable.

Bore Hole Cables

Furnished for all conditions of service, usual voltages, usual number and size of conductors, armored and unarmored. Our long experience in the manufacture of bore hole cables is at your service. We will gladly make recommendations and furnish estimates to those interested.

Lead Covered, Steel-Wire-Armored Cables—These cables resemble the ordinary wire-armored cables, but their construction is modified to take care of the longitudinal strains to which they are subjected when suspended in the bore hole.

The illustration shows how these cables may be conveniently installed in the bore hole by means of our cable clamps and cable terminals. With our improved method of applying the armor, and the suggested method of support, the strain is evenly distributed throughout the entire length of the cable.

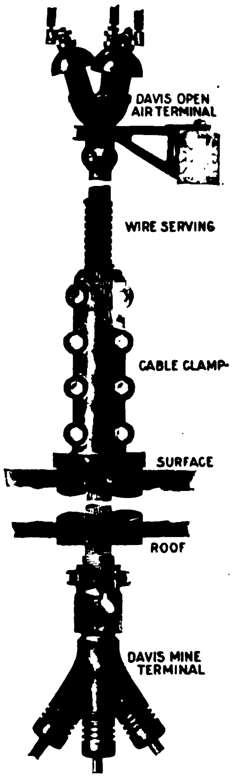
Non-Leaded Cables—We can furnish non-leaded cables for installation in boreholes when conditions permit their use. The outer braid may be as ordinarily furnished on braided cables, or may be our heavy Circular Loom finish.

Cable Accessories

We can furnish cable terminals for outdoor or indoor service, cable junction and joint boxes, jointing materials of all kinds and other cable accessories.

Information with Inquiries

Time will be saved in answering inquiries if complete information concerning kind and amount of material is given, such as quantity in feet or pounds; size in B. & S. G. or circular mils; solid or stranded; kind of insulation; operating voltage; kind of service; delivery point, etc.



Lead-Covered Steel-Wire-Armored Cable Installed in a Bore-hole, Complete with Supporting Clamp and Terminals, All of our Manufacture.

THE ECONOMY RAIL BOND CO.

Huntsville, Missouri

Manufacturers of

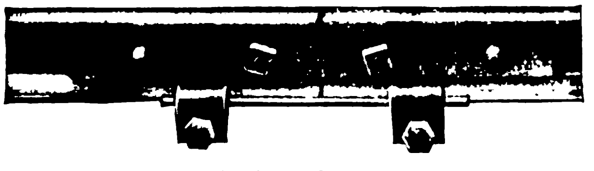
Patented Economy Rail Bond

Products

The Economy Rail Bond. Patented Oct. 13, 1914, and Jan. 23, 1917.

The Economy Rail Bond secures maximum conductivity of the rails without soldering, riveting or welding. There are no holes to drill. May be attached by unskilled labor in a few minutes by simply drawing up bolts with a wrench. Can be detached and used over again as it is not subject to wear.

It will last as long as the rails. In some of the low coal mines where mining machines are used the companies instead of buying new wire take down their return wire and bond the track with Economy Rail Bonds. Thereby making a big saving. A track equipped with these Bonds where they are properly put on does not give any trouble, as they are down out of the way of the wheel flanges, and the wire cannot be cut off by cars being off the track. We have mines where coal is being hauled over a mile, and no other Bonds on the track but the Economy. They have no bond troubles and would not use any other make of Bonds.



Cut shows Economy Rail Bond in place and that the bond does not interfere with the fish plate, also out of the way of the wheel flanges.

These Bonds are past the experimental stage. They are used exclusively by some of the largest coal companies in the country. Some companies now using them have repeated their orders a number of times.

All the tools necessary to put these Bonds on the track is a hammer, a small open end wrench, and a tool to clean the rail flanges.

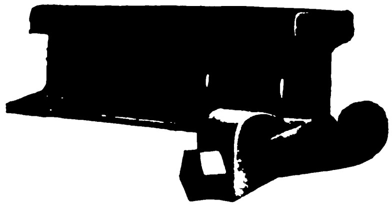
The clamp, which is a malleable casting lined with copper, is driven on the rail flange and the bolt tightened which holds it to its place.

The large area of copper to steel contact surface makes this Bond superior to any other.

Every electrician knows that the larger the contact surface in any electrical connection the better the connection and the less drop in the line. Our Bonds for 12-lb. rails have a copper to steel contact of 3¾ sq. inches.

The area of copper to steel contact surface runs from 3¾ sq. in. to over 6 sq. in. according to the size of the rails. We do not furnish the wire, as most all the coal companies have scrap wire they want to use and they can cut it in lengths to suit.

Old worn out bonds or short pieces of wire that ordinarily would be thrown away can be used just as well as brand new material. All that is necessary is that it is long enough to span the joint. The fish plate is not in the way so it is not necessary for the wire to be long enough to span it. All old wire over 8 inches long can be used.



Cut shows simplicity of attaching the Economy Rail Bond.

These Bonds never wear out. They can be used as many times as one cares to change them, thus they are always ready.

We know of a mine abandoned a few months ago which had electric haulage, three motors and over 5000 feet of motor road. This track was bonded with **Economy Rail Bonds,** and when the track was taken out every bond was taken off the rails and saved.

A trial order will convince any one that this is the most economical bond on the market.—Write for prices.

THE AMERICAN MINE DOOR CO.

CANTON, OHIO, U. S. A.

Manufacturers of

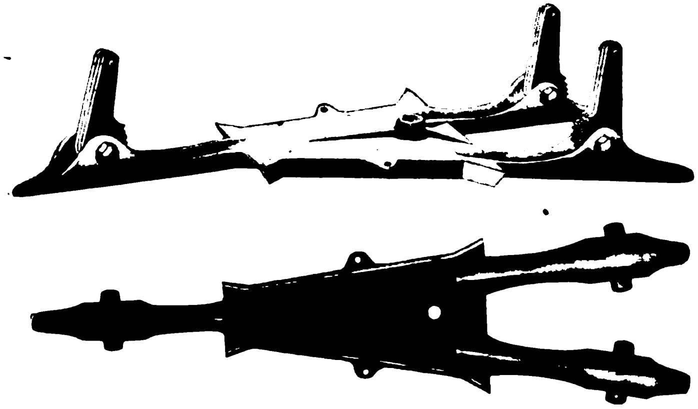
Canton Automatic Line and Track Appliance

Products

Trolley Frogs, Splices, Section Insulators, Cable Splices and Cable Splicing Tools, Automatic Trolley Switches, Hand Track Switches, The Canton Automatic Mine Switch; also manufacturers of the Canton Automatic Mine Door described in other section of The Mining Catalog.

Type 5 F Trolley Frog

This frog is made of malleable iron, angular or semicircular in section; a construction obtaining the greatest strength with the least weight. Nevertheless, they are sufficiently strong for any mine service.



Type 5 F Frog.

Installation and Operation

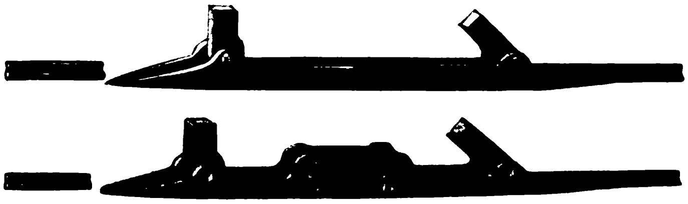
These frogs can be installed for either right or left switches without disturbing the main line. The dogs are removed from the frog, the frog placed against the line, the dogs replaced and fastened to the wire by striking the levers of the dogs with a hammer hard enough to make them grip the wire. The dog at the Y end holding the main wire is turned in the same direction as the dog at the point end. The branch wire may be inserted and fastened without removing the dog. A 5/8" hole is provided in the top of the frog for placing a hanger stub if a hanger is thought necessary.

The machanical construction is such that the trolley wheel will pass over the frog smoothly without rebounding. The position of the frog can be properly adjusted by sliding it along the wire, after loosening the dogs, hence it is not necessary to take it off when tightening up the branchwire. Since it can be installed without cutting the wire it is the best frog for temporary use, and due to its simplicity and ease of installation much time is saved by its use.

Canton Trolley Splice and Section Insulator Splice

These splices are made of malleable iron or brass, with our patent gripping device. They are made to take any of the usual shaped wires.

The installation is the same as that of the Frog; the ends are inserted under the raised dogs, drawn to the proper tension and fastened by hammering down the dogs. The connection is so perfect that there is no arcing, and the speed with which it can be installed makes it the most economical even though the old fashioned splice could be had for nothing.

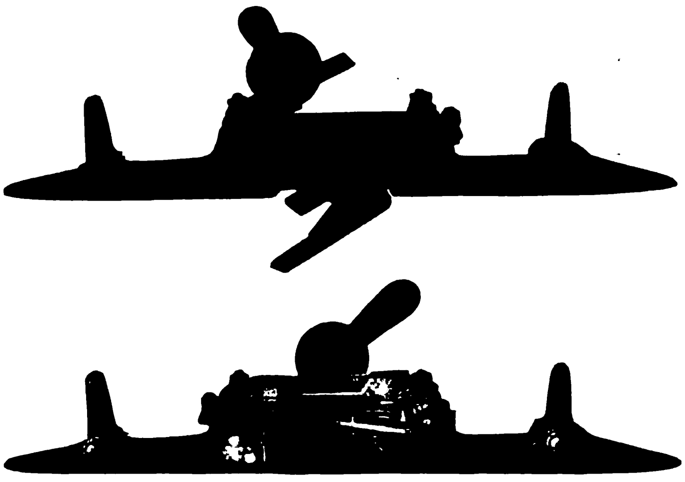


Splice and Insulator Splice.

The section insulator splice is a modification of the straight splice, having an insulated center. It is exceedingly useful when it is desired to install a cut-out switch, automatic section insulator, signaling device. The insulating material and fastenings have tensile strength equal to the splice itself.

The Canton Section Switch and Insulator

This switch is a combination of a well constructed switch and the Canton section insulator splice, made stronger to stand the extra strain. The mode of installation is the same as that of the frog and splice described in the preceeding. The switch mechanism consists of two levers and a push rod and two conducting parts. The conducting parts open on either side of the wire, and at sufficient distance not to touch the trolley wheel when passing. This arrangement gives a perfect contact when closed and offers a continuous contact for the trolley wheel. The insulator offers a continuous passage to the wheel when open and also offers safe passage in case, through an oversight, the switch should not be thrown.

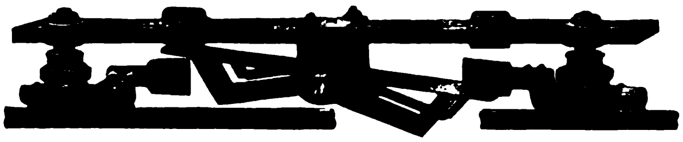


Hand Switch and Section Insulator.

The convenient position and angle of the handle secures ease and certainty of operation and safety and ease in releasing the hand from the handle after opening or closing. The leaves of the switch are easily replaceable and are inexpensive.

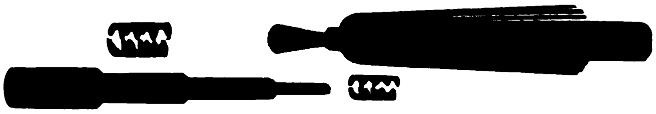
The Canton Automatic Electric Switch

This goes one step further than the switch just described in being automatic in operation. When used in connection with the insulated section splice it forms an automatic section insulator. When in use in this combination any section of the mine may have the power automatically turned on when the motor enters the section and cut out when the motor leaves it. The switch is separate from the insulator as shown in the cut, hence arcing is reduced to a minimum and the switch does not become inoperative as a result of corrosion from this cause. As well as acting as an automatic switch it may be used for the operation of automatic signaling devices. When a selective signal is required the switch may be placed on a short parallel trolley wire. The motorman cuases the wheel to take the branch by pushing the pole slightly; when the wheel takes the wire the switch will turn on any desired signal for which it may be wired. The switch is clamped to the trolley wire with a split clamp which tightens by screwing down a single hex nut. The clamps are applied to the straight wire without distorting it and the switch is very speedily installed.


Automatic Switch and Section Insulator.

The Canton Cable Splice

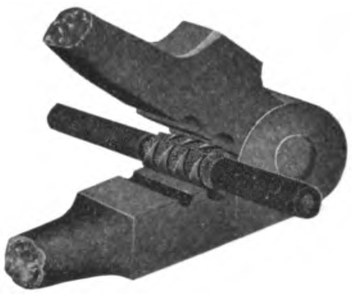
This is an extremely simple and also extremely speedy device for splicing machine and concentric cables. The splice sections consist of metal pieces notched as shown in the cut, matching into each other when squeezed together. The cable is spliced by uncovering and untwisting the ends and working them into each other. The sections are placed on the joint and squeezed together in the jaws of the tool. After the splice is made it is insulated with a rubber tube and insulating tape.


Concentric Cable Prepared for Splicing.

PRICE LIST.

		Per Doz.	Each.
Trolley Frogs, reversible	Malleable,	$18.00	$1.75
Trolley Splices	Malleable,	9.00	1.00
Trolley Splices	Brass,	18.00	1.75
Trolley Splices, Insulated	Maleable,		1.50
Trolley Splices, Insulated, with Hand Switch			6.00

	Per Hundred.
No. 4 Machine Cable Splice Sections	$ 7.50
No. 6 Machine Cable Splice Sections	7.50
No. 8 Machine Cable Splice Sections	15.00
No. 4 Concentric Cable Splice Sections Outer Conductor	7.50
No. 6 Concentric Cable Splice Sections Outer Conductor	7.50
No. 8 Concentric Cable Splice Sections Outer Conductor	7.50


Splicing Tool In Operation.

The tool is provided with two grooves for splicing concentric cables as well. Each set of conducting wires is insulated at a different place. The cable is best prepared for this by cutting as shown in the illustration.

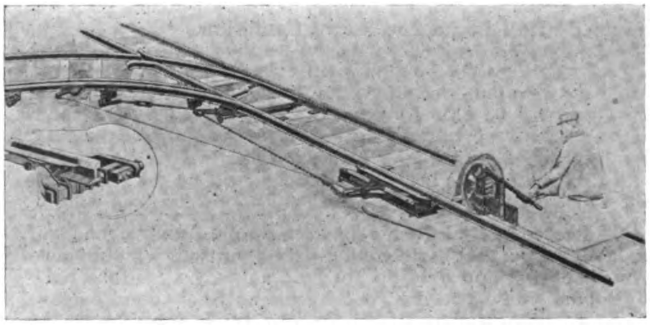
The Canton Automatic Mine Switch

This is a simple and effective track switch, automatic in action, controlled by the motorman from his seat on the motor. It may be used either for straight switching service or for making flying switches.

The machanism consists of a lever attached to the frame of the mtor capable of extending down and engaging the opening device—consisting of a trigger and paul. A cable from the trigger opens the switch while the paul holds the trigger back and the switch open. Beyond the heel of the switch on the branch track is a channel in line with the inner edge of the track and elevated above it. This is supported by a toggle joint operating a rocker arm which is also connected to the switch by a cable. After the motor passes the switch points the wheels engage the channel while the operating lever, by a trip, releases the paul, causing the trigger to resume the normal operating position. The channel, however, now depressed by the wheels holds the switch open. As soon as the last wheel is off the channel bar it rises and the switch springs back to its original position. In coming out of the switch the points are moved by the pressure of the wheel flanges.

In making flying switch the motorman cuts loose, operates the switch by the lever, runs through and the switch automatically closes, allowing the cars to take the full track.

With this switch in use the trip need not be stopped while the trip rider runs ahead to open the switch; flying switches may be made without even slacking the speed, permitting easier grades and saving a great deal of pushing. In addition, liability of accident to motorman or spragger is reduced or eliminated.


Automatic Track Switch.

ELECTRIC SERVICE SUPPLIES CO.

Manufacturer of Electric Railway and Mine Haulage Material

GENERAL OFFICES AND FACTORY:
17th and Cambria Streets, Philadelphia, Pa.

CHICAGO, ILL., Monadnock Bldg.
NEW YORK, 50 Church Street.
GEE ELECTRIC CO., Wheeling, W. Va.
GRAYSON RAILWAY SUPPLY CO., St. Louis, Mo.
ATLANTA, GA., 1526 Candler Bldg.
McCLARY-JEMISON MACHINERY CO., Birmingham, Ala.
LYMAN TUBE AND SUPPLY CO., LTD., Montreal. Toronto.

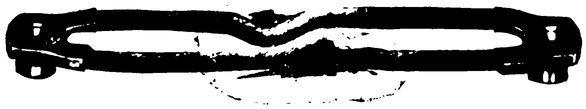
Products.

Electrical equipment for mine haulage systems; "Protected" Rail Bonds; Rail Bond Testers; Keystone Trolley Hangers, Clamps, Ears, Expansion Bolts; Porcelain and Glass Insulators; Garton-Daniels Lightning Arresters; Keystone Electric Block Signals; Pneumatic Signalling Systems; Electric and Magneto Signalling Systems; Keystone Water-Tight Telephones; "Safety-First" and other Signs—Illuminated and Plain; The Automotoneer—A Controller Regulator; Peerless Armature Repair Machinery; Trolley Material—Poles, Bases and Wheels; "Golden Glow" Headlights; Keystone Steel Gear Cases; Locomotive Gears and Pinions; Keystone Sand Driers; Keystone Lamp Guards.

All of the above lines and many more are fully covered in our complete mining catalogs, and in numerous special catalogs, copies of which will be sent to interested parties.

Type F Bond.

Type P-4-P Bond.



Type F-C-P Bond.

"Protected" Rail Bonds for Every Condition.

With your system bonded with "Protected" Rail Bonds, you will get maximum conductivity in your track return; your locomotives will be able to carry their full rated load without taking excessive current; you'll get fewer motor burn-outs; better lighting service; more cars per trip; less time per trip; and all this means that increased tonnage will be the inevitable result.

"Protected" Rail Bonds have terminals and strands of pure lake copper of high conductivity, united by the most improved forging and welding process known. In "Protected" Rail Bonds you get the well-known "Shot-Over" sleeve feature—a copper sleeve surrounding and protecting the strands at their point of emergence from the terminal, assuring you that the strands won't break at this point.

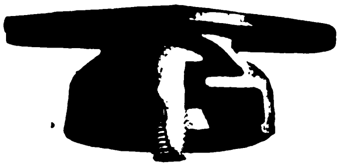
Made in both flat wire and cable forms, compressed terminal and pin driven types and are furnished to meet every possible service condition.

Many millions in daily service.

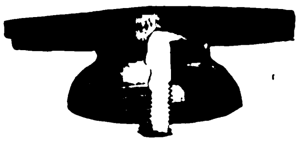
Have you our special Rail Bond Catalog?

Type K—Form 10

Type S—Form 8

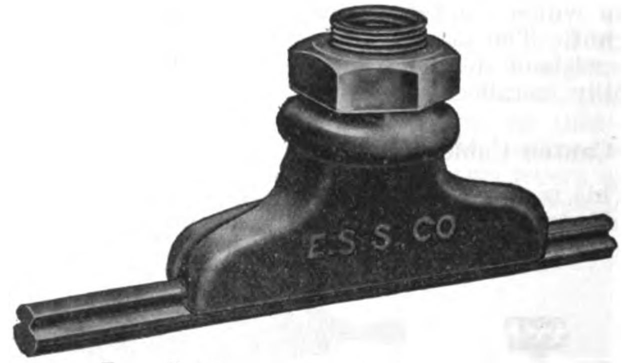


Type K—Form 2



Type G—Form 2

Typical Keystone Trolley Hangers.



Type C—Keystone Trolley Wire Clamp.

The Line of Keystone Overhead Material Is Complete.

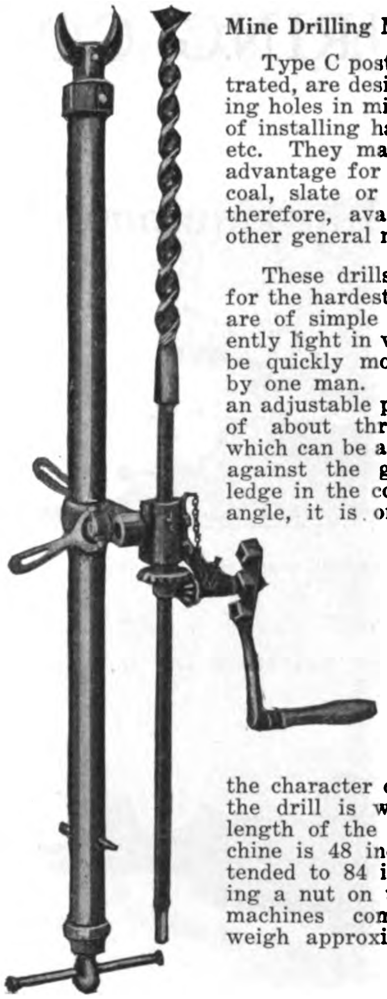
For supporting your trolley wire, your needs call for material that is the best; material that possesses properties of high insulation, great strength, proper design—material that has proven all this in the only thorough test, **the test of actual service.**

The entire line of Keystone Overhead Material is so varied and so flexible that your most exacting conditions can be met exactly.

Trolley hangers are designed for attaching direct to horizontal or vertical timbers or pipe, expansion bolts or to structural steel; are correctly and scientifically designed, and are insulated with Keystone Insulating Compound, standard for years in mining and railway service.

Keystone Trolley Ears and Clamps are made in many styles. The type C mechanical clamp shown above is a strong, cheap clamp, which has but three parts. They are easy to apply or remove, have a total depth of but 2⅝ inches, and are furnished for round, grooved and figure 8 wires.

Ask for Complete Catalog on Keystone Overhead Material



Type C.

Mine Drilling Machine.

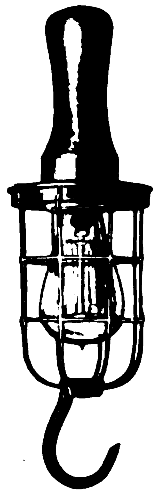
Type C post drilling machines, illustrated, are designed especially for drilling holes in mine roofs for the purpose of installing hangers for trolley wires, etc. They may also be used to good advantage for drilling at any angle in coal, slate or medium rocks and are, therefore, available for blasting and other general mine purposes.

These drills are of ample strength for the hardest kind of drilling and yet are of simple construction and sufficiently light in weight to enable them to be quickly moved about and handled by one man. They are equipped with an adjustable post, having an extension of about three-quarters its length, which can be anchored at the lower end against the ground or a projecting ledge in the coal. For drilling at any angle, it is only necessary to loosen the nut which holds the yoke. The position of the main post need not be changed.

Type C drills feed automatically, being equipped with feed bars, having either 10 or 14 threads per inch for fast or slow feeding, depending upon the character of the material in which the drill is working. The minimum length of the post in a standard machine is 48 inches, which may be extended to 84 inches by simply loosening a nut on the clamp. The drilling machines complete without augers weigh approximately 65 lbs.

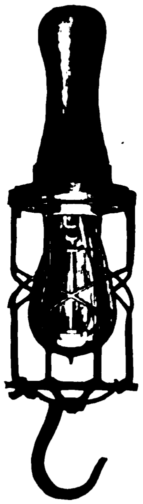
Keystone Portable Lamp Guards.

Keystone Lamp Guards are made for service, for service in mines, tunnels, engine rooms, repair shops, any place where requirements call for a safe, strong, durable lamp guard.



No. 12504.

No. 18997.

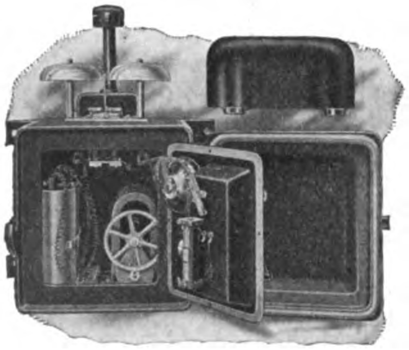


No. 18996.

Guards illustrated above are made entirely of malleable iron and steel parts and provided with well seasoned hard maple handles. Cages are of Bessemer steel wire, electrically welded at joints and all parts heavily tinned. All guards are insulated for 600 volts. Used for years by many of the largest operators throughout the country. Booklet on request.

Keystone Water-Tight Telephones.

The Keystone Water-Tight Telephone (Mine Type) is a mine telephone out and out. It has been designed for the most rugged conditions ever met in service. Every working part is absolutely sealed against the effects of gas or moisture. Even the bell clapper does not leave an opening in the case—it is operated by magnets inside the case, the magnetic field for operating same being transmitted through the iron. Down to the most minute details the Keystone Telephone is for hard, rough service, where the greatest reliability is demanded.



Keystone Telephone Opened Up.

Standard with many of the largest mining companies in the country.

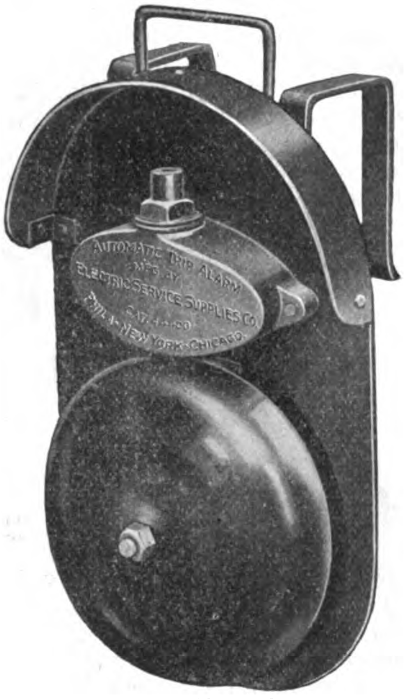
We have a special catalog on Keystone Mine Telephones. Have you a copy?

Automatic Alarm Gongs

Of the many safety appliances which are constantly put before the mining man, probably none are so vitally essential as automatic alarm gongs.

Suppose a locomotive is pushing a number of cars through a shaft at high speed or the locomotive is operating alone, can you imagine a more effective signal than the automatic alarm gong shown above? It is only necessary to hang the gong on the car which leads or on the locomotive if it should lead and you have a continuous alarm which can be heard for a distance of from 300 to 500 feet ahead of the approaching trip. The faster the trip operates, the louder the gong rings.

They operate automatically with the vibrations of the car or locomotive on which they are hung, so furnishing a continuous alarm whenever the trip is in motion. This feature alone warrants their use for safety, for such a safety appliance to be really valuable must not be dependent on the men in charge for operation.



No. 44000 Alarm Gong With Torch.

They consist of a steel frame, with a handle and hooks for attaching, and are equipped with heavy pressed steel or cast brass gongs, 10 inches in diameter. Two heavy steel hammers are suitably mounted beneath the gong and operated energetically at the slightest movement of the car on which the device is suspended. The spring arrangement is simply and strong and yet extremely sensitive and all working parts, being beneath the gong, are protected from injury or rough usage.

They are furnished with or without the torch as illustrated. Write for bulletin.

Catalogs.

The various general and special catalogs published by this Company on Electric Mine Equipment should be in the library of every mining man. They will be sent on request.

FLOOD CITY MANUFACTURING CO.

JOHNSTOWN, PA.

Manufacturers of

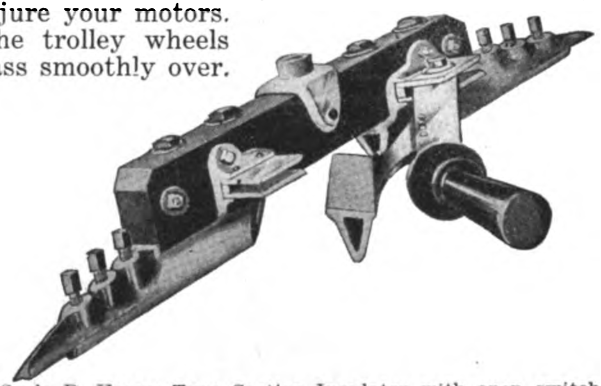
Brass and Bronze Castings and Electrical Mine Equipment

Products

We manufacture a complete line of Section Insulators. The "Diamond" Mining Trolley and Parts, Trolley Wheels, Bushings, Trolley Poles, etc. Splicers, Trolley Wire Frogs, Junction Blocks, Hand Trolleys Feed Wire Connectors, Tee Connectors, Mine Car Oilers, Mine Sprinklers, Brass and Bronze Parts and Castings for Mining Machines, Electric Locomotives, Pumps and for all purposes around a mine, Acid Resisting Metals for all purposes. We repair all classes of electrical and mechanical mining machinery. Our 1917 Catalogue now ready, write for one.

Type HH and Style D Section Insulators

On this page we illustrate two different styles of Section Insulators, which are: a combined Section Insulator and Line Switch in one. This switch is right on your trolley line and is a great cost cutter. It saves your trolley wheels, trolley line, breakers, motors and motor gears, because there is no dead section in your trolley line, just a straight, smooth, metallic underrun; no breaking and remaking the contact with a jump to injure your motors. The trolley wheels pass smoothly over.



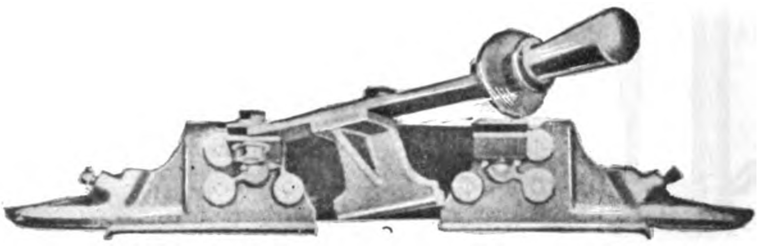
Style D, Heavy Type Section Insulator with open switch. Note complete break.

Style "D" Section Insulator Switch

The dedstructive arcing features are eliminated by using these types of switches. It stands for increased efficiency in your trolley line equipment; it is easy to install and operate; it enables you to cut out certain sections of your trolley line equipment without interruption to the whole system; it does away with the old style Section Insulator and separate Switch. It is more efficient than both, and cheaper than either to install and maintain.

Brass and Bronze Castings

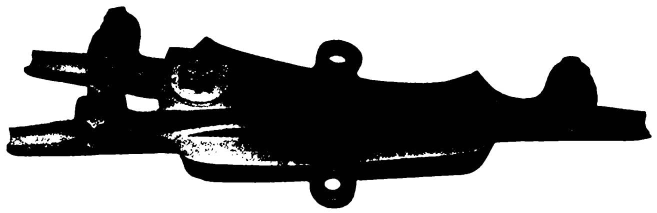
We have made a ceraful study of conditions around coal mines as to the needs of Brass and Bronze or Acid Resisting Metal Castings and we are prepared to furnish hepair parts for mining machines, locomotives, pumps, etc.



Type H H, Section Insulator with switch open, showing broken circuit in trolley line.

Type HH Section Insulator

These goods have our guarantee and meet actual mining conditions.



Bronze Trolley Frogs

These frogs are made of high grade bronze with the pan and other parts, subject to wear, made extra heavy. They are furnished right or left hand with binding clamps and set screws malleable iron galvanized.

All frogs listed below are for round or grooved trolley wire, and have an over-all length of 17 inches and width of 5½ inches.

Bronze Trolley Splicer with ⅜ inch Steel Set Screws on each end. Made for Round, Grooved or Figure 8 Trolley Wire.

These splicing ears are made of a high quality of bronze, 10 inches long and is intended to be adjusted without solder. The fastening is obtained by ⅜ inche by 1 inche set screws being ampley secure for ordinary conditions. Solder may be used in addition, however, the strength of the fastening being materially increased thereby.

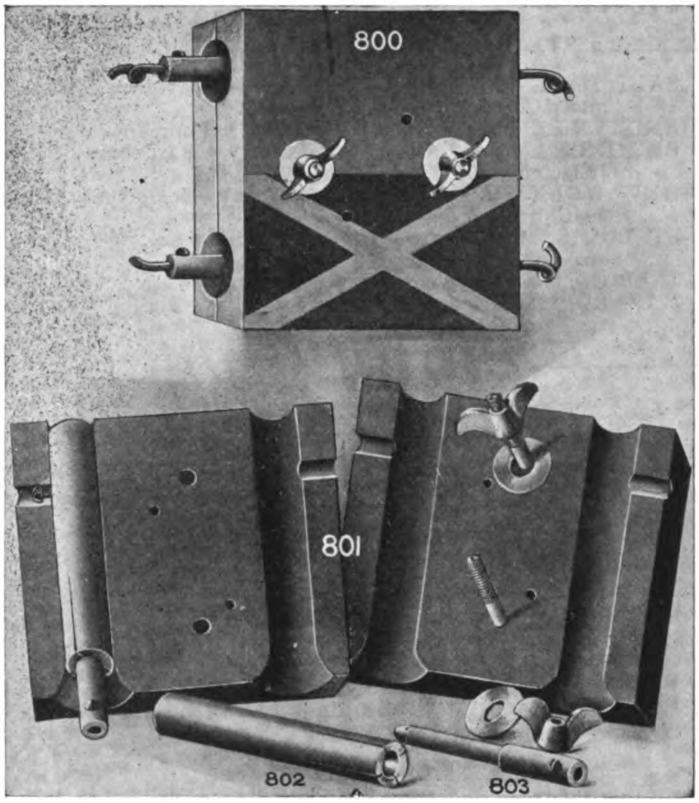
Bronze Trolley Splicers

These splicing ears are made of a high quality of bronze, 10 inches long and is intended to be adjusted without solder. The fastening is obtained by ⅜-inch by 1-inch set screws being, amply secure for ordinary conditions. Solder may be used in addition, however, the strength of the fastening being materially increased thereby.

The above splices are furnished with or without hangers, also in 10" or 14" sizes.

FLOOD CITY MANUFACTURING CO.

JOHNSTOWN. PA



Junction Blocks

will help your mining machine do its work better, safer, quicker—and that's why your mine should be equipped with Junction Blocks.

How They Are Installed

They are easily and securely fastened to some suitable place (usually to poles at or near the room entrances). Permanent connections are then made between the block

Why They Are Simple and Efficient

Because the mining machine operator comes along and simply plugs his machine connections into the nearest Junction Block.

They are efficient because a full and complete contact is instantly and constantly assured.

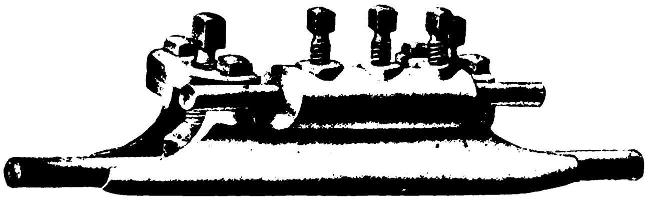
The trouble and annoyance so common with the old method of hooking the mining machine cable over the feed or trolley wire is entirely eliminated.

Though inexpensive, Junction Blocks render exceptionally efficient service and give sure satisfaction.

DIAMOND TROLLEY POLES

Made from selected grade of oak and ash wood. Perfectly straight, smooth, dry and free from knots.

Cat.	Size	List Pr. Ea.
549	3'10" x 2½" x 1¾"	.70
550	4' x 2½" x 1¾"	.70
551	4'06" x 2½" x 1¾"	.80
552	5' x 2½" x 1¾"	.80
553	5'06" x 2½" x 1¾"	.70
554	6' x 2½" x 1¾"	1.00
555	7' x 2½" x 1¾"	1.10
556	8' x 2½" x 1¾"	1.20
557	9' x 2½" x 1¾"	1.50



"Diamond" Mining Trolley and Parts

The "Diamond" Mining Trolley increases efficiency,—thats the advantage. Note why.

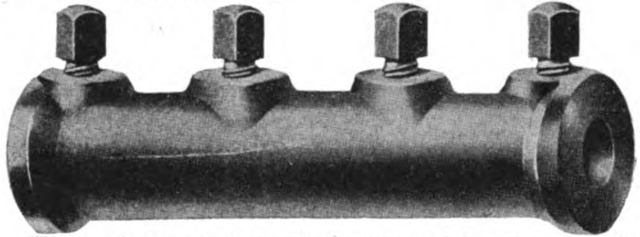
The pole head is smooth and oval backed, making nearly a straight line connection—which prevents harp or wheel catching on the trolley line. It will not wedge or catch in a frog but slides smoothly through.

Note the reinforced harp support between pole head and harp is strong—insures perfect contact and connection. It does not bend or loosen—even if the trolley leaves the wire and strikes against the roof.

We have increased the length of the cable connection. It gives a greater contact surface making a stronger and more effective connection.

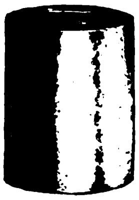
No. 506—Diamond Trolley Complete with Pole, Pole Head, Harp, Wheel and Axle Pin.

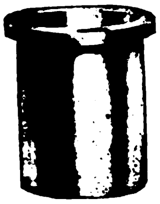
Two Way Wire Connector



These wire connectors are longer and heavier than the ordinary connector and are fitted with four sheridized malleable set screws. In ordering the above wire connectors state size of wire used.

Brass and Bronze Bushings and Bearings





Your motors and machines should be fitted with Flood Ctiy Bushings and Bearings. It is their best life insurance. Nothing but the finest of materials go into our brass and bronze castings. The superiority of Flood Cicty Service in filling your order quickly will mean great savings to you.

Brass and Bronze Castings, Bushings and Bearings to any specifications. A request will bring expert information on any bearing problem you may have. Write for 1917 catalogue.

ELECTRIC RAILWAY EQUIPMENT CO.

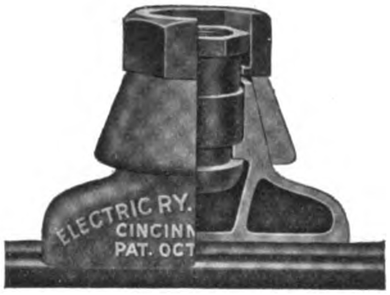
General Offices and Factory: CINCINNATI, OHIO

FACTORY REPRESENTATIVES:

PITTSBURG, PA.—Cooke-Wilson Electric Supply Co., Penn Avenue and Barbeau Street.
CHARLESTON, W. VA.—Cooke & Wilson Company.
CHICAGO, ILL.—Electrical Material Company, 618 W. Jackson Blvd. (formerly The W. R. Garton Co.)
DENVER, COLO.—The O. H. Davidson Equipment Co., 1633 Tremont Street.
BLUEFIELD, W. VA.—Superior Supply Company.
EL PASO, TEXAS—The O. H. Davidson Equipment Co., Mills Bldg.
SALT LAKE CITY, UTAH—The O. H. Davidson Equipment Co., Walker Bank Bldg.
KNOXVILLE, TENN.—C. M. McClung & Company.
BIRMINGHAM, ALA.—Moore-Handley Hardware Co., (Electrical Dept.)
NEW YORK, N. Y.—Electric Railway Equipment Co., 30 Church Street.
ST. LOUIS, MO.—Grayson Railway Supply Co., 405 La Salle Bldg.
JELLICO, TENN.—Arthur L. Ware.
HAZARD, KY.—Arthur L. Ware.

Products

"Sure Grip" Trolley Clamps; 22 types of Insulated Mine Hangers; Trolley Frogs; Section Insulators; Line Section Switches; K-I type Trolley Splicers; Clark Trolley Splicers; Trolley Wheels; Trolley Bushings; Trolley Harps, and a complete line of overhead trolley material for mine use.



Sectional View
Sure Grip Clamp.

Sure Grip Trolley Clamp

The "Sure Grip" Trolley Wire Clamp was designed for Mine use and has been adopted as standard by the majority of mines in the United States. While not the cheapest clamp considering first cost alone, it has been conclusively proven by actual service to be more economical and satisfactory than any other clamp ever placed on the market.

A Few of the Good Points to Remember

(1) One operation attaches clamp to hanger and secures trolley wire in the jaws with the grip of a vise.

(2) Cut shows how all parts are locked together—impossible to have a "Sure Grip" Clamp with any part missing.

(3) Figure 8 Clamp takes all sizes of figure 8 wire—grooved clamp all sizes of grooved wire.

(4) The "Sure Grip" is installed in just one-half the time required for any other clamp.

(5) No exposed threads to be corroded by mine water, clamp can be instantly removed from hanger and used in other parts of the mine when required.

(6) Short jaws—no obstruction to trolley wheel on curves.

(7) Wide opening jaws, no difficulty to insert trolley wire which has become kinked or bent.

(8) No adjustment necessary with "Sure Grip" Clamp. Attach to hanger stud, insert trolley wire and tighten hexagon nut.

(9) If necessary to "take up" slack in trolley wire, loosen hexagon nut on "Sure Grip" Clamp one turn, wire will not drop out of clamp but is free to slip through jaws.

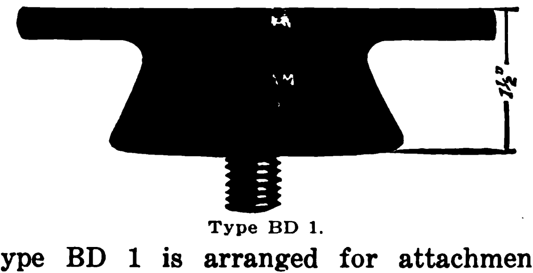
"Sure Grip" Trolley Clamps are furnished in malleable iron or bronze metal, also with "feed in" or strain cups instead of plain. Fully covered by patents.

Two million "Sure Grip" Clamps in actual use.

Black Diamond Hangers

Black Diamond Hangers are arranged for attachment direct to mine roof. Type BD 2 is arranged with an internally threaded boss for attaching to any ⅝" expansion bolt. The wide bearing surface at the top resists transverse strains on curves. It is cast with hexagon shoulder near the top which provides an easy way of drawing the hanger tight against the roof. Its extreme shortness recommends it to mines having a low roof.

Type BD 2.
For Expansion Bolt.



Type BD 1.

Type BD 1 is arranged for attachment by means of lag screws.

GENERAL ELECTRIC COMPANY

General Office:
Schenectady, N Y

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Sales Offices
In All Large Cities

Electrial Supplies for Mines

G-E Miners' Lamp

This light, compact outfit includes a lead plate storage battery with steel carrying case, and MAZDA lamp in cap reflector.

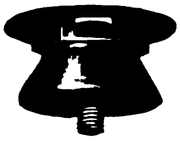
Form H.

The outfit will furnish light through a solid angle of 130° for 12 hours continuous operation on each charge.

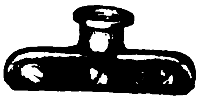
Line Material

For overhead construction the strength and durability of G-E Line Material has been proved in actual service.

In strength, durability and ease of installation G-E Line Material is surpassed by none.

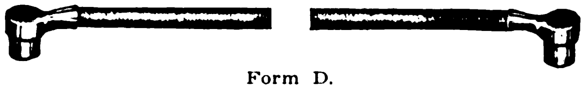


Form H (Low).



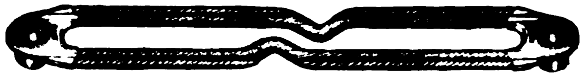
Form A.

Form M.

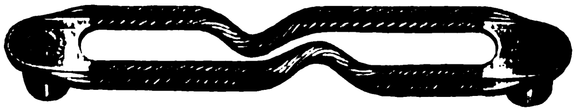


Form D.

Form DT.



Form FT-9.

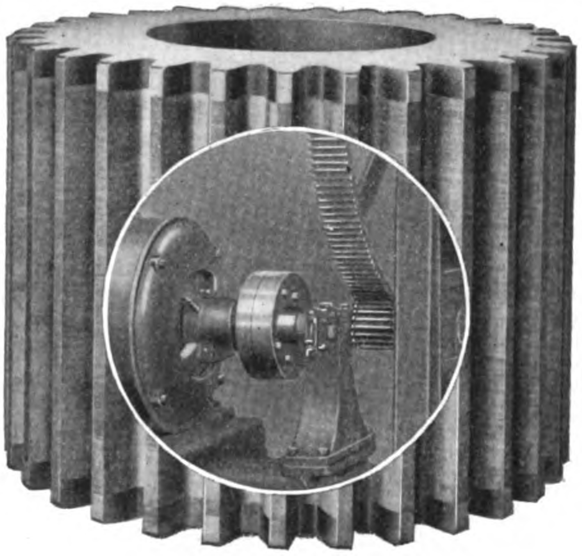


Form F-9.

G-E Railbonds

Tests in a Pennsylvania colliery showed an enormous increase in production after the installation of G-E Compressed Terminal Railbonds.

Locomotives made 18 trips per day instead of 12 as formerly with less load on the generator.



Noiseless Gearing

Fabroil Gears, are vermin proof, and oil and water proof. They do not deteriorate with age and are unaffected by atmospheric conditions.

Everything electrical for the mine is included among G-E products. Write our nearest office about your requirements.

THE OHIO BRASS COMPANY

MANSFIELD, OHIO

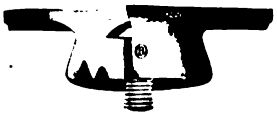
30 Church St., New York **306 Fourth Ave., Pittsburgh** **343 S. Dearborn St., Chicago**
Charleston Electrical Supply Co., Charleston, W. Va.

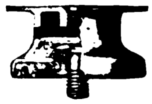
Products:

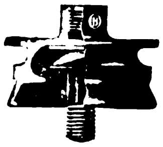
Mine trolley hangers, trolley clamps, trolley wire splicers, trolley wheels and harps, rail bonds, bonding tools, trolley frogs, trolley cross-overs, feeder wire insulators, strain insulators, high tension insulators, section insulator switches, expansion bolts, etc. These are described and listed in our General Catalog. We also make a complete line of Brass Valves and Steam Specialties listed and described in our Valve Catalog. Separate bulletins describe Crouse-Hinds Imperial Luminous Arc, Carbon Arc, and Incandescent Headlights for which we are general sales agents in the United States. Copies of any or all of these catalogs sent on request.

Mine Trolley Hangers

Made in various designs to meet varying service conditions.


Timber

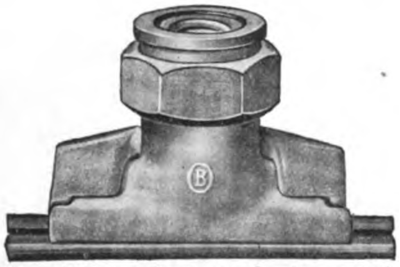

Universal


Roof

Dirigo insulation is used in these hangers. Its electrical and mechanical strength is remarkable.

O-B Modoc Trolley Clamp (Patented)

Fits tightly against hanger when aligned with wire. Gives plenty of clearance for wheel. Grips wire firmly. Rugged enough to meet the most severe conditions. Takes round, grooved or figure 8 wire.



O-B Type M Mine Section Insulator Switch (Patented)

Used to cut out section of trolley wire not in use.

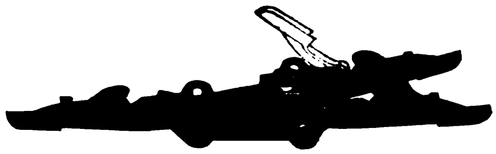
When closed it has smooth metallic under-run which prevents sudden rush of current to motors.

Current carrying capacity is fully sufficient.

Opened or closed by driver without stopping locomotive.

O-B Type D Trolley Frog (Patented)

Has only six parts including Renewable Cam Tips.



Installed easily and quickly.

Strong and sturdy for severe service.

O-B Trolley Wheel and Harp

Wheel is made of high quality bronze.

Wearing surfaces extra thick. Furnished with Graphite Bushing and large oil reservoir filled with grease.

Harp is especially designed for mining service. Pivot, set forward of the wheel axle gives trailing action so that harp easily follows irregularities in the trolley wire.

O-B Compressed Terminal Rail Bonds

O-B Rail Bonds make for low resistance in the return track circuit.

Illustration shows bond for use around splice plate. We also make bonds for under plate.

O-B Rail Bonds furnished in all sizes and capacities for every service.

WESTINGHOUSE ELECTRIC & M'F'G CO.

EAST PITTSBURGH, PA.

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San Francisco, Cal.
Seattle, Wash.
Syracuse, N. Y.
Toledo, Ohio.
Washington, D. C.

*W. E. & M. Co., of Texas.

Mine Trolley-Line Material

Westinghouse Type BF and BI Suspensions, and Type RE Clamp are combined in such way as to meet every demand for insulated trolley wire suspension in mines.

Type BF Suspension and Type RE Clamp, with an expansion bolt (Fig. 1), forms an excellent suggestion for supporting trolley wire from the mine roof.

Type BP Suspension and Type RE Clamp, with a special washer and log stud, are used for supporting from a wooden beam, or—

Type BL Suspension and Type RE Clamp and two log bolts (Fig. 2) can be used for the same purpose and require less head room.

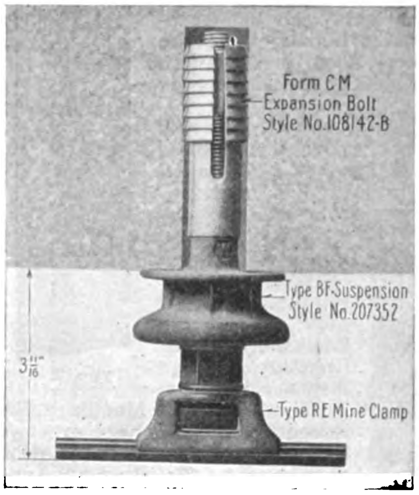


Fig. 1—Type BF Suspension and RE Clamp.

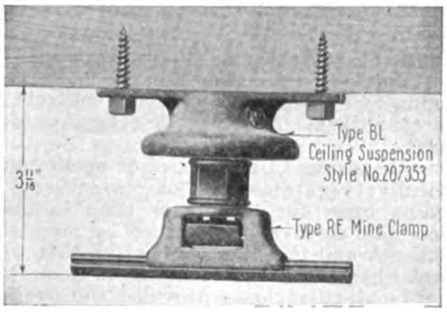
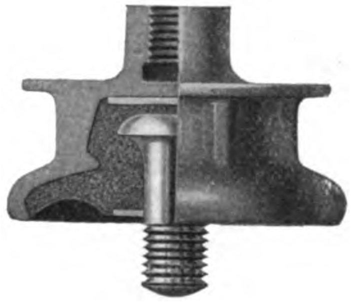
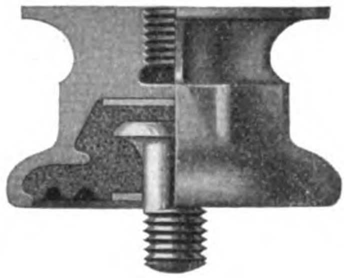


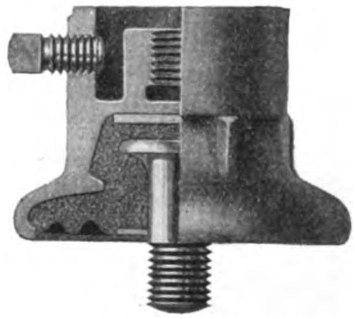
Fig. 2—Type BL Suspension and RE Clamp.



Type BP Suspension.



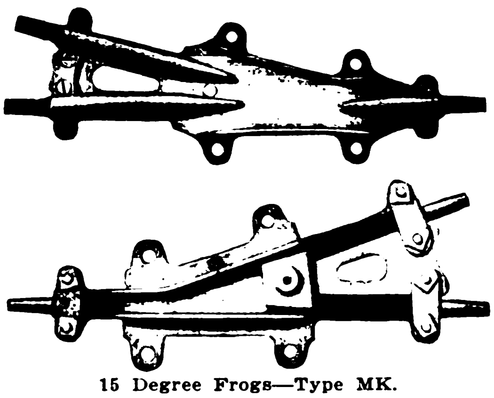
Type LH Suspension



Type JW Suspension

Mechanical Characteristics

The insulating material used in the suspensions is moisture proof, heat resistant and of high mechanical strength. It is moulded into shape under pressure, so that it is very dense and capable of resisting heavy strains. A vertical pulley of 6,000 pounds is required to pull the stud from the moulded insulation.

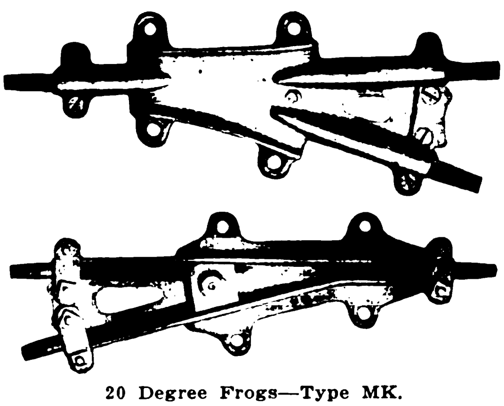


15 Degree Frogs—Type MK.

Type MK Frogs

The Frogs have malleable-iron sherardized bodies, with flexible, bronze approaches and are straight underrunning.

This new line of Sherardized Mining Trolley Line Material is fully described in Catalog 6-A, ask nearest office for a copy.



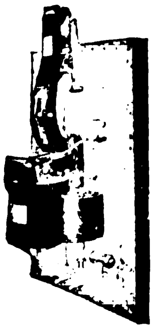
20 Degree Frogs—Type MK.

The Automatic Reclosing Circuit Breaker Co.

Main Office and Works, COLUMBUS, OHIO

Representatives

Jos. B. Noros, 50 Church St., New York City.
Superior Supply Co., Bluefield, W. Va.
Iron City Electric Co., Pittsburgh, Pa.
McClary-Jemison Machinery Co., Birmingham, Ala.
Railway & Industrial Engineering Co., Peoples Bank Bldg., Pittsburgh, Pa.
Minerallac Electric Co., 1043-45 Washington Blvd., Chicago, Ill.
Ambler, Ott & Riter, Kearns Building, Salt Lake City, Utah.
William Miller Tompkins, 4813 Haverford Avenue, Philadelphia, Pa.
Tennessee Mill & Mine Supply Co., Knoxville, Tenn.
Metropolitan Electric Mfg. Co., Blvd. and 14th St., L. I. C., New York City.
Metropolitan Electric Mfg. Co., 146 Summer St., Boston, Mass.
T. Weiss, 1420 Majestic Bldg., Milwaukee, Wis.
Louis J. Kaiser, 146 Park Blvd., Detroit, Mich.
Central Electric Co., 36 Adelaide St., West, Toronto, Canada.

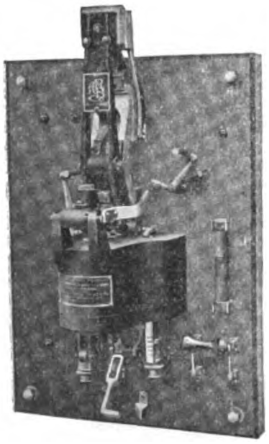

Type "D"

Automatic Reclosing Circuit Breakers are designed for the **complete protection** of any D. C. circuit. They are built for any operating voltage up to 600 volts (nominal) and in any capacity up to 2,000 Amperes.

Automatic Reclosing Circuit Breakers afford complete protection because both their opening and closing are governed entirely by load conditions. The cycle of operation is as follows: When an overload occurs the Automatic Reclosing Circuit Breaker opens automatically; regardless of load conditions, it remains open for a definite time interval, which time interval is obtained by means of a dashpot and is adjustable; after this time interval has elapsed the Automatic Reclosing Circuit Breaker automatically closes provided the overload has been removed from the line. **If the overload still remains on the line, however, the Automatic Reclosing Circuit Breaker makes no attempt to reclose but remains open until the overload is removed when it closes instantly and automatically.**

Out of this cycle of operation arise the following advantages to be had by the use of Automatic Reclosing Circuit Breakers:

(1) Reduction in abuse to electrical equipment;
(2) Elimination of unnecessary loss of time;
(3) Safety for linemen and operators;
(4) Automatic operation of substations;
(5) Sectionalizing of electrical circuits underground and reducing fire hazard.

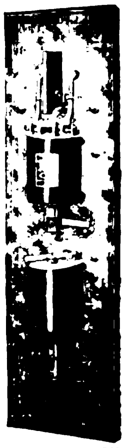

Type "AA"

Automatic Reclosing Circuit Breakers for the protection of independent power circuits are built in three types; namely, Types "AA," "C" and "D," the use of one or the other of these depending upon the class of service and the capacity of breaker required. In all these types the operating coil, overload coil and resetting coil are completely housed and protected in a cast iron frame which carries the operating mechanism. They are designed to conform with standard circuit breaker practice as regards temperature rise

The following table gives the type, rated capacity, overload calibration range, and dead load calibration range:

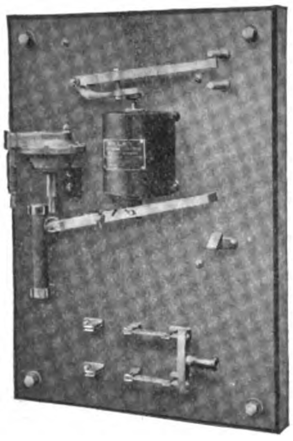
Type	Rating Amperes	Overload Calibration Range		*Deadload Calibration Range	
		Minimum Amps.	Maximum Amps.	Minimum Amps.	Maximum Amps.
C	200	100	300	75	200
C	400	200	600	75	400
AA	300	200	500	75	300
AA	400	300	600	75	400
AA	500	300	700	75	500
AA	600	400	900	100	600
AA	800	600	1200	100	800
D	1200	900	1800	200	1200
D	2000	1200	3600	200	2000

*Dead load is the load on the line when the breaker is open represented by the amperes this load would take if the breaker were closed. The dead load setting of the breaker should never exceed 75% of the overload setting.

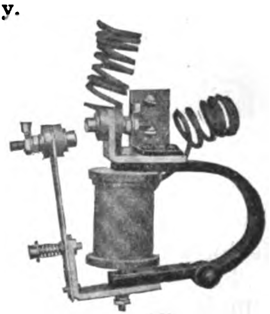

Type "F-2"

When an Automatic Reclosing Circuit Breaker is installed in a feeder which ties in with a bus bar, a line, or a system of distribution supplied with power from a source or sources other than through the Automatic Reclosing Circuit Breaker, then the use of a relay is required in connection with the Automatic Reclosing Circuit Breaker as follows:

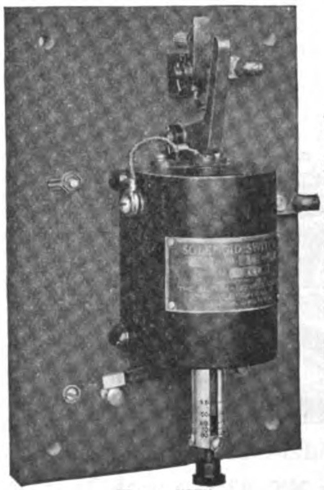
The type "F-2" Feeder Circuit Relay is required when the feeder in which the Automatic Reclosing Circuit Breaker is installed is tied in with a line or system of distribution supplied with power from another station or other stations. A type "F-2" Relay is required with each Automatic Reclosing Circuit Breaker under these conditions.


Type "M"

The type "M" Master Relay is required when there are two generators in the same station connected to the same bus, and an Automatic Reclosing Circuit Breaker is installed in each generator circuit. One type "M" Relay is then required to control the operation of the two Automatic Reclosing Circuit Breakers so that they open simultaneously and close simultaneously.


Type "J"

The type "J" Reverse Current Relay is applicable to any type of Automatic Reclosing Circuit Breaker where reverse current protection is required. This relay is mounted on the back of the Automatic Reclosing Circuit Breaker panel and gives reliable operation on less than five percent reverse current.


Type "H"

Type "H" Automatic Reclosing Storage Battery Charging Switches are designed to protect storage batteries under charge against discharging, by opening should the charging current fall to zero; and to reclose the charging circuit automatically when the charging voltage rises to a point which will permit the battery to charge. They are built in 50 Ampere and 100 Ampere capacities and are provided with an adjustment so that they may be set to close at any desired value of charging voltage within limits of 1 and 1.5. They are furnished for any voltage range specified within these limits.

A. F. DAUM

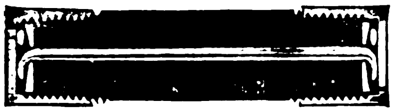
PITTSBURGH, PA.

Sole Manufacturer of

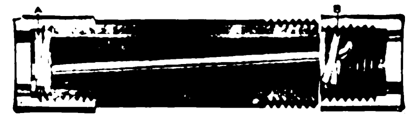
The Daum Refillable Cartridge Fuse Shells

For Electric Light and Power

Below are illustrated our various forms of Type "B" Fuses. The following forms of fuses are made from 3 to 60 Ampere, 250 to 600 Volts, N. E. C., Dimensions.



Form 1—Thread Washer Type.



Form 2—Spring Washer Type.

Form 3—Cotter Wire Type.

In the above three forms Commercial Fuse Wire is used, and it should be remembered in reloading all 250 Volt Fuses up to 30 Ampere the wires will carry 100% more than their rating. For example, in reloading a 10 Ampere Fuse 5 Ampere Wire should be used; in 20 Ampere, 10 Ampere Wire, etc.

All 250 Volt Fuses over 30 Amperes should be reloaded at their rating. All 600 Volt Fuses from 1 to 60 Ampere should also be reloaded at their rating.

Form 4—Strip Type.

In reloading this type Fuse the strip should be used at its rating, which is shown on all "Daum" Fuse Strip boxes.

The following prices govern all Type "B" Fuses:

TYPE "B" 250 VOLTS

Catalog No.	Amps.	Length over all	Caps	Tubes	No. in package	List Price
33	3	2"	9/16"	½"	25	.30
34	4	2"	9/16"	½"	25	.30
35	5	2"	9/16"	½"	25	.30
36	6	2"	9/16"	½"	25	.30
38	8	2"	9/16"	½"	25	.30
39	10	2"	9/16"	½"	25	.30
40	15	2"	9/16"	½"	25	.30
41	20	2"	9/16"	½"	25	.30
42	25	2"	9/16"	½"	25	.30
43	30	2"	9/16"	½"	25	.30
90	30	3"	13/16"	¾"	25	.60
91	35	3"	13/16"	¾"	25	.60
92	40	3"	13/16"	¾"	25	.60
93	45	3"	13/16"	¾"	25	.60
94	50	3"	13/16"	¾"	25	.60
96	60	3"	13/16"	¾"	25	.60

TYPE "B"—600 VOLTS

Catalog No.	Amps.	Length over all	Caps	Tubes	No. in package	List Price
161	1	5"	13/16"	¾"	10	.75
162	5	5"	13/16"	¾"	10	.75
163	10	5"	13/16"	¾"	10	.75
164	15	5"	13/16"	¾"	10	.75
165	20	5"	13/16"	¾"	10	.75
166	25	5"	13/16"	¾"	10	.75
167	30	5"	13/16"	¾"	10	.75
170	30	5½"	1 1/16"	1"	10	1.00
171	35	5½"	1 1/16"	1"	10	1.00
172	40	5½"	1 1/16"	1"	10	1.00
173	45	5½"	1 1/16"	1"	10	1.00
174	50	5½"	1 1/16"	1"	10	1.00
176	60	5½"	1 1/16"	1"	10	1.00

65 to 600 A 250 to 600 V—N. E. C. Dimensions.

Our latest style Type E, or knifeblade fuse, has been improved by having the copper blade with rounded edge cast into the cap. This makes a better finished article, easier to insert in the clips, and though our cost is considerably higher we have not increased the prices.

The hanger inside the tube has been strengthened by putting more metal of a special mix in the body, making them more rigid.

TYPE "E" 250 VOLTS OR BLADE

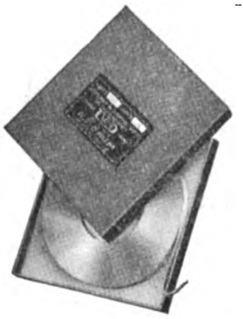
Catalog No.	Amps.	Length over all	BLADES Wide	BLADES Thick	Diam. Tubes	No. in Pkg.	List Price
101	65	5⅞"	¾"	⅛"	1"	10	$1.65
103	75	5⅞"	¾"	⅛"	1"	10	1.65
105	85	5⅞"	¾"	⅛"	1"	10	1.65
107	100	5⅞"	¾"	⅛"	1"	10	1.65
110	105	7⅛"	1⅛"	3/16"	1½"	5	4.00
112	125	7⅛"	1⅛"	3/16"	1½"	5	4.00
114	150	7⅛"	1⅛"	3/16"	1½"	5	4.00
115	175	7⅛"	1⅛"	3/16"	1½"	5	4.00
116	200	7⅛"	1⅛"	3/16"	1½"	5	4.00
120	225	8⅝"	1⅝"	¼"	2"	2	7.00
121	250	8⅝"	1⅝"	¼"	2"	2	7.00
122	275	8⅝"	1⅝"	¼"	2"	2	7.00
123	300	8⅝"	1⅝"	¼"	2"	2	7.00
124	325	8⅝"	1⅝"	¼"	2"	2	7.00
125	350	8⅝"	1⅝"	¼"	2"	2	7.00
126	375	8⅝"	1⅝"	¼"	2"	2	7.00
127	400	8⅝"	1⅝"	¼"	2"	2	7.00
131	425	10⅝"	2"	¼"	2½"	2	8.00
133	475	10⅝"	2"	¼"	2½"	2	8.00
135	500	10⅝"	2"	¼"	2½"	2	8.00
137	550	10⅝"	2"	¼"	2½"	2	8.00
138	600	10⅝"	2"	¼"	2½"	2	8.00

TYPE "E" OR BLADE. 600 VOLTS

Catalog No.	Amps.	Length over all	BLADES Wide	BLADES Thick	Diam. Tubes	No. in Pkg.	List Price
180	65	7⅞"	¾"	⅛"	1¼"	5	3.00
182	75	7⅞"	¾"	⅛"	1¼"	5	3.00
184	85	7⅞"	¾"	⅛"	1¼"	5	3.00
187	100	7⅞"	¾"	⅛"	1¼"	5	3.00
190	100	9⅝"	1⅛"	3/16"	1¾"	5	5.00
191	125	9⅝"	1⅛"	3/16"	1¾"	5	5.00
192	150	9⅝"	1⅛"	3/16"	1¾"	5	5.00
193	175	9⅝"	1⅛"	3/16"	1¾"	5	5.00
194	200	9⅝"	1⅛"	3/16"	1¾"	5	5.00
200	210	11⅝"	1⅝"	¼"	2½"	2	7.00
201	225	11⅝"	1⅝"	¼"	2½"	2	7.00
202	250	11⅝"	1⅝"	¼"	2½"	2	7.00
203	275	11⅝"	1⅝"	¼"	2½"	2	7.00
204	300	11⅝"	1⅝"	¼"	2½"	2	7.00
205	325	11⅝"	1⅝"	¼"	2½"	2	7.00
206	350	11⅝"	1⅝"	¼"	2½"	2	7.00
207	375	11⅝"	1⅝"	¼"	2½"	2	7.00
208	400	11⅝"	1⅝"	¼"	2½"	2	7.00

Submit sample of any old code fuse you are using and we will make it in a refillable type. This is an exclusive feature possible only with DAUM type of fuse.

LIST PRICE OF FUSE STRIP NOT SCORED



	Feet Per Lb.	Renewals Per Lb.	Price per Lb. List
65A	55	145	$2.00
75A	48	128	2.00
85A	39	108	2.00
100A	35	96	2.00
125A	24	66	2.00
150A	21	54	2.00
175A	18½	46	2.00
200A	14	35	2.00
225A	15	30	2.00
250A	14	28	2.00
275A	13	26	2.00
300A	12	25	2.00
350A	10½	21	2.00
400A	9	18	2.00
450A	4 2-3	9	2.00
500A	4 1-3	8	2.00
600A	4 2-3	7	2.00

The fuse strip for reloading 5 to 30 Ampere Fuse is put up in ¼-lb. rolls, listing at $2.00 per roll, and can be supplied in any of these sizes. Each roll averages 500 renewals.

The fuse strip for reloading 31 to 60 Ampere Fuse is put up in ½-lb. rolls, listing at $1.00 per roll, and can be supplied in any of these sizes. Each roll averages 400 renewals.

ECONOMY FUSE & MFG. CO.

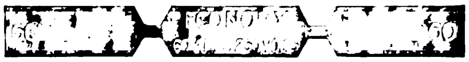
KINZIE & ORLEANS STS, CHICAGO

Manufacturers of

Economy Renewable Cartridge and Plug Fuses

Products

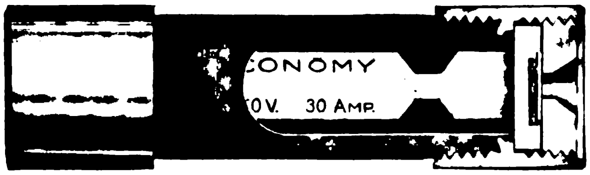
Economy Fuses are made in three general types (Ferrule, Knife Blade and Plug) with a full line of capacity ranges for all commercial voltages. The fusible elements are of the "Drop out" Renewal Link type, accurately rated and of definite design. Every part of an Economy Fuse is built on the "Safety First" principle, which means that the design is right from an electrical standpoint and that the material entering into the construction of the completed fuse is the best that money can buy.


Ferrule Type "Drop Out" Renewal Link.

Knife Blade Type "Drop Out" Renewal Link.

Economy Fuses Save

Eighty per cent of fuse maintenance yearly as compared to the cost of securing adequate protection by the use of old-style, non-renewable fuses.



Sectional View—Ferrule Type Fuse.

Economy Fuse Users Include

Industrial plants, large corporations, light and power companies, mining and smelting companies, department and large stores, publishing companies, flour mills, food product plants, hotels, theatres, public buildings, steamships, wireless stations ashore and afloat and various departments of the United States Government.

Who Are Economy Fuse Users

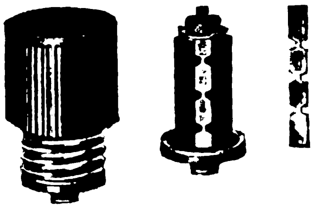
The United States Government, the Panama Canal Zone, great steel mills, ammunition and arms plants, powder mills, establishments in every branch of industry, theatres, mines, schools, department stores, flour mills, hospitals, etc., etc.

Why They Use Economy Fuses

Because Economy Fuses cut yearly fuse costs 80% and furnish proper protection under all conditions of service.

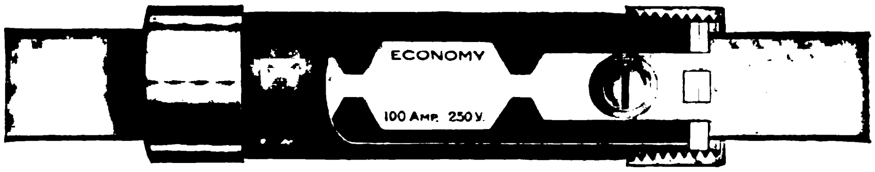
The "Drop-Out Renewal Link

It is the heart of an Economy renewable fuse. It instantly restores a blown Economy Fuse to its original efficiency. A stock of "Drop Out" Links always on hand represents only a small investment.


Economy Renewable Plug Fuse—Full View—Unassembled View—The "Drop Out" Renewal Link. Of the same standard of high quality as Economy Renewable Cartridge Fuses.

Contracts

Many of the larger fuse users are now contracting with the manufacturers or jobbers of Economy Fuses for a full year's requirements. Cost thus being guaranteed, the saving for twelve month's fuse maintenance may be determined in advance.



Sectional View—Knife Blade Fuse—"Drop Out" Renewal Link In Place.

Samples

Any capacities sent on request, provided they are to be used for comparison and tests.

Complete Stocks Carried By All Leading Jobbers. Ask for Catalog 44 When Ordering Samples.

MONARCH REFILLABLE FUSE CO.

147-153 Leslie Street, Buffalo, N. Y.

Manufacturers of

Monarch Refillable Fuses

Products

The Monarch Company manufactures a complete line of the refillable fuses.

Why Discard the Expensive Part?

In the manufacture of fuses the fuse element is the least expensive item; it is the cartridge that costs the money—why throw it away and buy a new one every time a fuse blows?

Monarch Refillable Fuses are so constructed that when they blow, the fuse element can be replaced; making virtually a new fuse at trifling cost and in a couple of minutes.

The superiority of the refillable fuse and the economy in its use is becoming so generally recognized that in a recent proceeding, as appears by the published report of the Bureau of Standards of its investigation of the refillabe fuse, Lewis W. Downs, General Manager of the D. & W. Fuse Company of Providence, R. I., made the statement:

> "At the present time we have a type of refillable fuse complete and designed and tested, which we can use if that situation is forced on us."

In the same proceeding Mr. Guy Cunningham, representing several of the old type-non-refillable fuse manufacturers, also said:

> "If we put out one, as we certainly shall if this becomes the proper thing to do."

These statements clearly indicate the general adoption of the refillable and much safer and economical fuse.

How the Monarch Fuse Stands Government Tests

The following communication from the Ordinance Department of the Watervleit Arsenal shows how the Monarch 125 amp. 250 volt fuse stands the severe tests of Government inspection.

Watervleit Arsenal, Watervleit, N. Y.

Gentlemen: 1. The Monarch refillable fuse furnished by you for comparative test at this Arsenal has been tested with the following result:

(a) A suddenly applied current of 138 amperes ruptured the Monarch fuse and it is believed that if the element had been totally enclosed in its case (part of the case was cut open for observation purposes) it would have ruptured at about 120 amperes.

(b) A suddenly applied current of 170 amperes failed to rupture one of our regular stock fuses, until the third attempt had been made.

(c) Owing to its simple construction a Monarch fuse can be refilled in five minutes, while one of our regular fuses takes half an hour to refill.

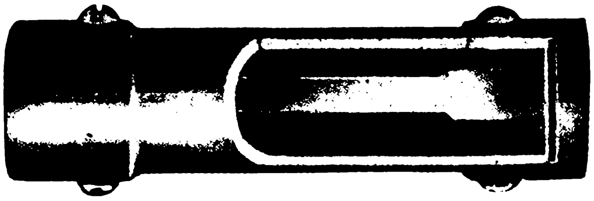
* * * * * * *

Respectfully, W. W. GIBSON, Col. Ord. Dept. Comdg.

The first cost is practically the only cost. Figure out for yourself just how much this will save you each year.

Illustrating Different Types

Ferrule Type.



Type A. 1 to 60 Amp. 600 Volt.

61 to 100 Amp. 600 Volt.

Made in all standard types and sizes and guaranteed to conform to underwriters' specifications as to rating and operating requirements.

Our system means a reduction of 90% in your fuse expense.

All Types—All Sizes

The Monarch Refillable Fuse is manufactured with ALL COPPER ends, and if you do not see the size outlined in our Bulletin No. 5 or advertising matter, mail in a drawing of the exact length over all, the exact diameter of the cap, the amperage and voltage of the fuse, and when our fuse is forwarded to you, it will fit into your standard blocks without any change, or, if your fuses are special, they will fit your special blocks.

All-Copper Ends

The Monarch Refillable Fuse is the only fuse manufactured with all-copper ends, as copper will not corrode when placed subject to moisture and gases, which are found in the mines.

Quick Detachable Ferrules

The ferrule type has the quick detachable ferrule, which is a time saver in the refilling, as time means money in keeping the electrical mine machinery in operation at all times.

Fuse Clips

If you are using the old style fuses with the type "A" contacts and would like to equip your switchboard with the National Electric Code Standard Fuse Clips, we can furnish you with the clips, and you can mount them on your switchboard. Write in for full information regarding the Monarch All-Copper End Fuse.

WRITE FOR CATALOG NO. 2 BEFORE ORDERING FUSES

Calebaugh Self-Lubricating Carbon Co.

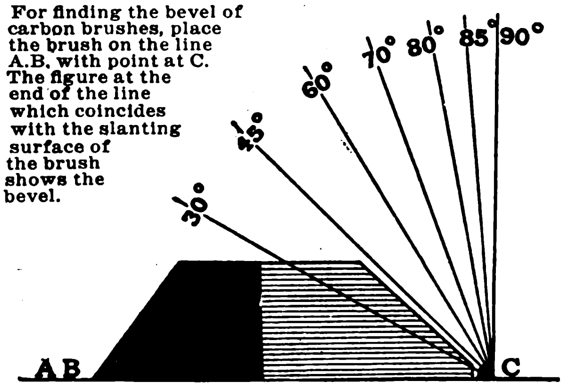
Incorporated

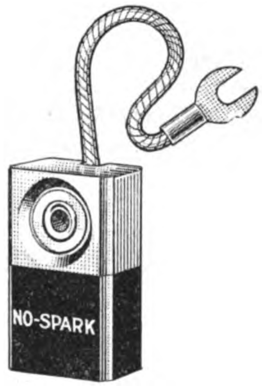
1503 Columbia Ave., PHILADELPHIA, PENNA.

Makers of

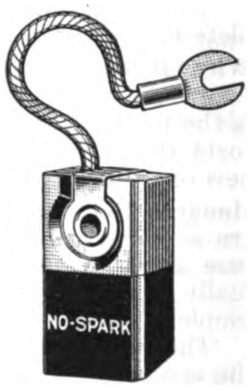
High Grade Carbon, Graphite and Metallic Brushes

For finding the bevel of carbon brushes, place the brush on the line A.B. with point at C. The figure at the end of the line which coincides with the slanting surface of the brush shows the bevel.

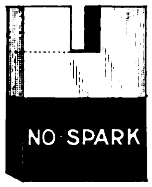




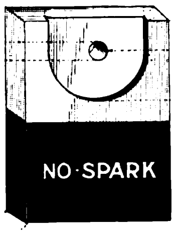
Type SS Riveted.



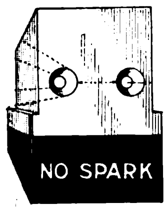
Type CS-2 Riveted.



Type G



Type S 1
One or Two
Holes.



Type H 1

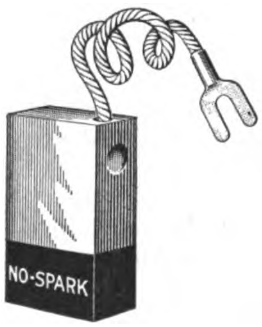
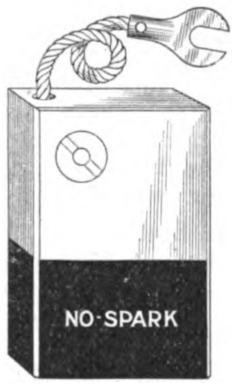
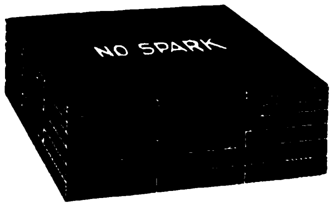


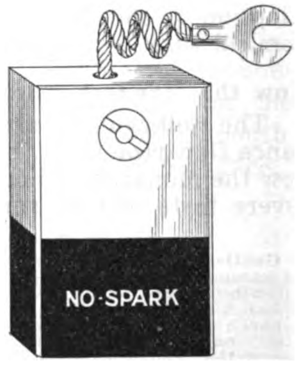
Fig. K.



Type CS2B



Carbon Brush Plates.
8 x 3"



Type SSB

We manufacture Brushes to meet all the requirements of your operating conditions "a catalogue sent upon request."

Notice.

The advantage in ordering Brushes from us you get the best suited grade for your machine. This will mean cool frictionless and sparkless commutation. No annoying delays. No unnecessary electrical losses, and stops that rapid deterioration of the commutator. We are the only makers of the "No-Spark Brush."

Deliveries made promptly in three days.

Le Valley-Vitae Carbon Brush Co.

Main Office and Works, 521 W. 23rd Street
NEW YORK, N Y

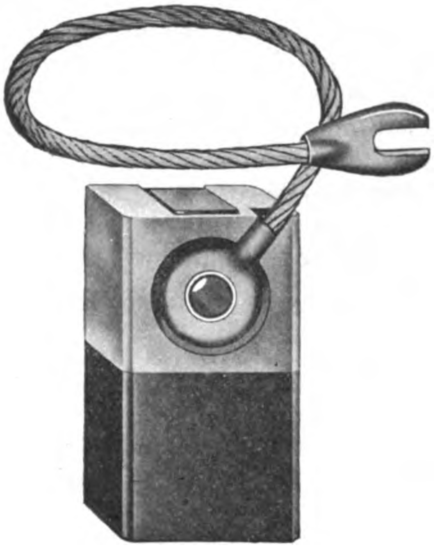
SALES OFFICES

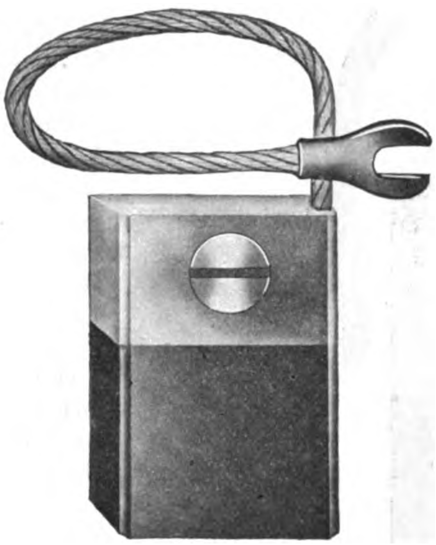
PITTSBURGH, PA., Commonwealth Bldg. BIRMINGHAM, ALA., 3 South 20th St.
NEW ORLEANS, LA., 7928 Zimple St. CLEVELAND, OHIO, Wade Building
HUNTINGTON, W. VA.

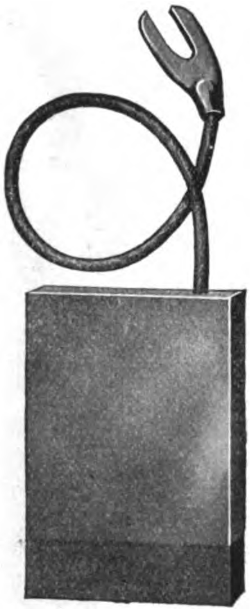
The selection of a carbon brush to accomplish an express result is oftentimes a difficult matter for both the designing and operating engineer.

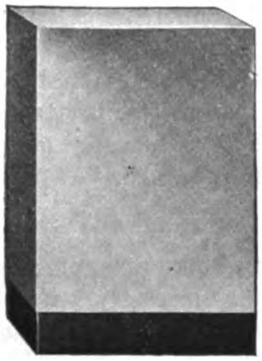
Le Valley Brushes are now designed in grades or series in varying degrees of hardness, resistance, and current densities to meet all conditions of service. Each grade with suggestions as to its application, is fully described in a new catalog, with curves by the Electrical Testing Laboratories, New York.

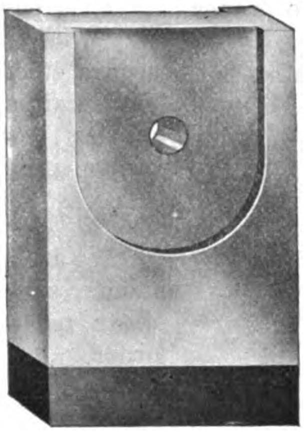
It is felt that this information will be of service to users by assisting them to select the proper brush for their particular conditions.

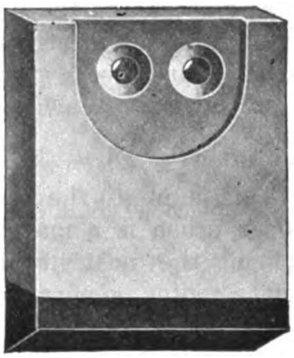












Made up in any shape or size for any make of machine. A grade for every service.
Prompt deliveries. Trial sets furnished.

PITTSBURGH CARBON BRUSH CO.

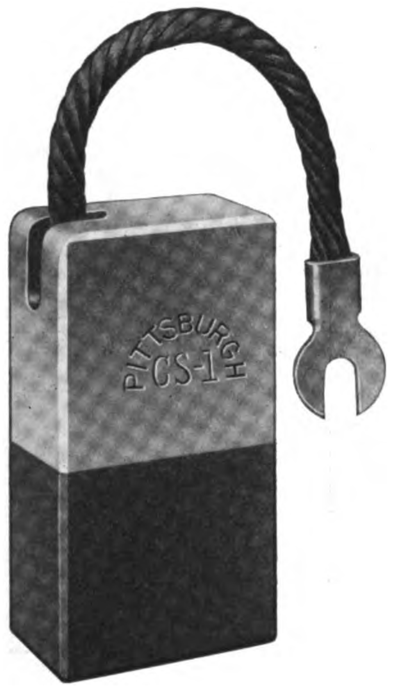
N. S. PITTSBURGH

Commutation Engineers

and

Manufacturers of Highest Grade Carbon Brushes

Has it ever occurred to you that you can save from 40% to 80% on your electrical repairs by using the proper brush on your Motors and Generators?



Engineers and those responsible for the proper performance of electrical equipment have, within recent years, been giving considerable attention to the subject of carbon brushes.

This is due to the fact that the selection of the proper brush is a matter of prime importance in securing the most efficient and economical service from a motor, generator or controller.

Inefficient operation of many machines, which is often charged to faulty design or other conditions, has been due to the use of brushes which were not suitable for the service required.

A brush that will operate satisfactorily on one machine will very often give poor service on another, although there be no radical difference in the design or application of the two machines.

There are a number of factors entering into the selection of a brush of the proper grade, some of which are voltage, current density, peripheral speed of commutator, style of brush holder, and a number of other conditions, all of which are factors of more or less importance in determining the right brush to use in order that there will be no undue heating, excessive friction, no sparking and that wear on the commutator and brushes will be kept down to a minimum.

Our high grade brushes do not contain any lubricating compound and are practically frictionless, and give the commutator that much desired polish which is indicative of perfect commutation.

All our brushes are fully guaranteed for the service for which they are recommended.

It is our earnest desire to cooperate in every way with our customers in order that they may secure efficient and economical service from their electrical equipment, and to this end we invite inquiries pertaining to carbon brushes or other carbon products which we manufacture.

We are specially equipped to make prompt shipments, and in cases of extreme necessity we can make partial shipment day following receipt of order.

Characteristics of all our grades are shown in our Catalogue, which will be mailed on request.

ADDRESS DEPT. "K."

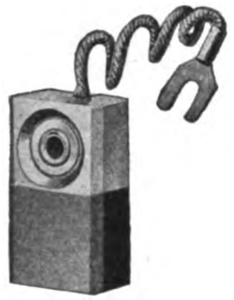
STACKPOLE CARBON COMPANY

ST. MARY'S, PA.

Makers of

Motor and Generator Brushes
Carbonized Work in all its Branches
High Grade Dry Cells

Engineers and those responsible for the proper performance of electric equipment have discovered that carbon brush expense can be reduced materially and at the same time it is only possible to obtain the highest efficiency by the use of Stackpole Carbon Brushes. These results are assured due to their absolute uniformity and superior composition. Emphatically "YES" is the reply that any experienced engineer gives when asked if Stackpole Brushes give satisfactory results.



Stackpole Brushes composed of carbon, graphite, carbon-graphite, metal and metal-graphite are the result of extensive experiments and a thorough practical knowledge of brush requirements. They are self lubricating, have maximum flexibility, minimum voltage drop, highest current density, lowest specific resistance and lowest coefficient of friction. They eliminate sparking and are absolutely noiseless. Every brush is tested before shipment.

The Stackpole Carbon Company manufacture brushes that are giving satisfaction in all classes of service. Their engineers are ready and anxious to solve any proposition whether for fan, vacuum-cleaner, industrial motors or generators (A. C. or D. C.), automobile starters, generators and magnetos, converters, boosters or other sub-station equipment, railway motor or other traction machines. All these as well as large generators or other central station equipment are handled in the most efficient manner.

This Company has spared no expense in assembling a staff of the best electrical engineers and chemists for research work.

The Stackpole Company have become the largest independent carbon manufacturers in the United States and are still growing. Their main office, laboratories (Chemical and Electrical) and factory buildings are situated in St. Mary's, Pennsylvania.

They make a specialty of prompt shipment.

Send for the Stackpole catalogs showing characteristics and prices of all grades.

THE STERLING VARNISH COMPANY

TRADE TODD PROCESSES MARK

PITTSBURGH, PENNA., U. S. A.

TRADE TODD PROCESSES MARK

Insulating Varnishes & Compounds

Refined Linseed Oil, Iron and Steel Protective Paints, Hot Metal Paint

General

The efficient upkeep of the insulation of electrical apparatus demands care and attention. Upon the life of the insulation depends that of the machine itself. Just as bearings last longer with good oil so good varnish will prolong the life of insulation and motors, regularly treated with a coat of varnish which will protect their coils from the deleterious action of humidity, acid fumes and the continued strain due to the electrical pressure itself combined with the oxidizing effect of the air used to ventilate them, will give surer and better service during a much longer time. The varnish used must be designed for the work as are the Sterling Insulating Varnishes and Compounds. They have been the Standard of quality for 30 years.

Products

Sterling Clear Air Drying Varnish
For quick varnishing of either new or repair work, which cannot be baked. High dielectric. Good body. Smooth firm coat. Oil, acid and water proof. Dries rapidly without baking.

Sterling Black Air Drying Varnish
For same purpose as above where a black instead of a clear varnish is desired. Good dielectric. Good body. Smooth firm coat. Acid and water proof. Dries rapidly. No baking.

Sterling Black Insulating Paint
Flame proof, acid and water proof, insulating and finishing. Rapid air drying. For wiring, splices, moulding, service boxes, battery boxes and general purposes.

Sterling Extra Black Finishing Varnish
Quick drying. Lustrous deep non-fading black. Oil proof. For finishing armatures, field coils and winding generally.

Sterling Extra Insulating Varnish
Clear baking. Firm and mechanically strong. Binding and cementing. Maximum oil, acid and water proofness. For all windings requiring high insulation and mechanical strength including oil immersed transformer coils.

Sterling Flexible Black Baking Varnish
Flexible, elastic, heat enduring, oil and water proof. For all windings requiring high electrical insulation and heat endurance. Also as baking enamel for metals.

Sterling Raw Refined Linseed Oil
A perfectly pure linseed oil obtained by the refining from crude oil all the water soluble and other impurities which detract so seriously from its value.

Sterling Iron and Steel Enamels
Protective coating for iron and steel structural work. Long lived. No action on metal. Not acted upon by elements. Therefore afford the most efficient protection. Furnished in clear, black, green, brown and gray.

Sterling Hot Iron Black
A paint designed for the protection of hot metal such as boiler heads, engine parts, etc. Shows maximum life under the most trying circumstances.

The above are only a few of the materials manufactured by the Company. Its engineering department is at the disposal of those needing special materials or special information in regard to practical up-to-date problems in the insulating or metal protection field.

Catalog

A catalog containing not only lists of various materials manufactured but also much valuable information and tables will be mailed upon request.

Additional information and process specifications will be sent by letter on special questions regarding insulation practice.

Packages

Our materials are supplied in the following standard packages: 1 quart cans, 1 gallon cans, 5 gallon cans, 30 gallon barrels, 50 gallon barrels. Also, when desired, in steel barrels. For such an extra charge is made but refunded less freight charges when returned to our factory.

Agents Who Carry Our Stock of Sterling Varnishes

Robertson Sales Co., Birmingham.
Frank Ridlon Co., Boston.
McCarthy Bros. & Ford, Buffalo.
Electric Service Supplies Co., Chicago.
The Hendrie & Bolthoff Mfg. & Supply Co., Denver.
The Graham-Reynolds Electric Co., Los Angeles.
Curtis & Carhart, Inc., New York.
Electric Service Supplies Co., Philadelphia.
Holabird Electrical Co., San Francisco.
Pacific States Electric Co., Seattle.
The Wesco Supply Co., St. Louis.
Dawson & Co., Ltd., Montreal.
Dawson & Co., Ltd., Winnipeg.

ELECTRICAL MATERIAL COMPANY

Formerly THE W. R. GARTON COMPANY

CHICAGO

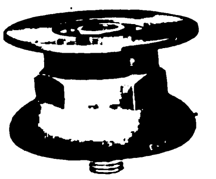
Electrical Mining Supplies

"Black Diamond" Hangers

Flanged and Expansion Types. They save "head room." Tested at the factory for 5000 volts. With our **"Sure Grip" Trolley Clamps**

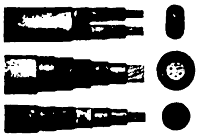
they have long been standard with mining men. There is no "stronger" combination made in design or performance. Only one operation necessary to install clamp.

Combination Mine Hanger



For direct attachment to mine roof or to roof timber. A new design of exceptional merit. A special lag screw furnished for roof timber attachment and expansion bolt for attaching to mine roof.

Mining Machine Cable



Duplex—Form A and B concentric. We have specialized on mining machine cables for years. It's one of our "hobbies".

"Diamond Point" Bits and Bit Steel

Cut to length. Made from an unusually high grade carbon steel. Keystone and all standard shapes.

"Diamond" Puncher Picks

Made for all makes of machines. Fit well and wear well. Another one of our "hobbies".

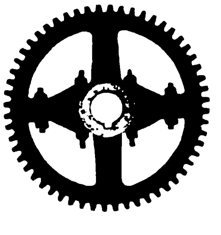
Trolley Frogs

Made in right, left and V shapes, for any size or design of wire, from a composition which has worn unusually well.

Brattice Cloth

Of exceptional quality in which only selected fibres have been used and these very closely woven and fireproofed. Furnished in several grades.

Gears and Pinions



VanDorn and Dutton. This is a guarantee of maximum service at a minimum price. Gears and pinions cannot be made better. Let us quote you on yearly contract.

LET US QUOTE YOU

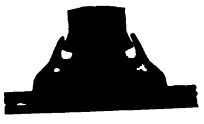
on the following

SUPPLIES & EQUIPMENT

Anchors—Guy
Armature Coils and Rewinding
Armature Twine
Armatures
Arresters—Lightning
Bars—Commutator
Bases—Trolley
Bearings—Trolley Wheel
Braces—Cross Arm
Brackets—Flex. Street Ry.
Brackets—Insulator
Breakers—Circuit
Bushings—Graphite
Carbon Lamps
Catchers—Trolley
Circuit Breakers
Clamps—Trolley Wire
Coils—Armature and Field
Commutator Bars
Commutator Refilling
Commutators
Compounds—Insulating
Conduit—Fibre and Clay
Conduit—Flexible, Non-Metallic
Conduit—Rigid Iron
Connectors—Trolley Wire
Connectors—Wire and Cable
Cord—Bell and Register
Cord—Cotton and Silk Lamp
Cord—Trolley and Arc Lamp
Cross Arms—Fir and Yellow Pine
Cross Arms—Iron and Steel
Cutters—Sleet
Ears—Trolley
Electrical Supplies—General
Field Coils and Rewinding
Forks—Trolley
Frogs—Overhead Trolley
Gear Cases
Gears and Pinions
Grounds and Ground Plates
Hangers—Trolley Wire
Harps—Trolley
Headlights—Electric Car
Insulation—Moulded
Insulating Cloth
Insulating Tape
Insulator Pins and Brackets
Insulator Supports
Insulators—Feed Wire
Insulators—Glass
Insulators—High Voltage
Insulators—Porcelain
Insulators—Strain
Lamps—Incandescent
Lighting Standards—Ornamental
Line Material—Overhead
Mine Supplies—Electric
Packing—Journal
Packing—Metallic Wool
Paints—Insulating
Pins—Insulator
Pole Line Hardware
Pole Tops
Poles—Cedar
Poles—Iron and Steel
Poles—Trolley
Rail Bonds
Railway Supplies—Electric
Retrievers—Trolley
Rope—Wire and Manilla
Sand Driers
Strand Wire—Galvanized
Tape—Friction and Rubber
Treads—Safety Step
Trolley Bases
Trolley Ears
Trolley Frogs
Trolley Harps
Trolley Poles
Trolley Wheels and Bushings
Tungsten Lamps
Waste—Cotton and Wool
Wire—Asbestos Covered Magnet
Wire—Magnet, S. & D. C. C.
Wire and Cable—Rubber Covered
Wire and Cable—Weatherproof

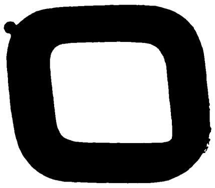
Type "S.M." Hangers, Form 1

An exceptionally short hanger for unusually low roofs. Petticoat type. With our **"Wire Lock" Trolley Clamps** we have another remarkable combination.

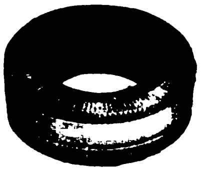


Made in mal. iron only, for round fig. 8, or grooved wire. Requires only one operation to install.

"Salamander" Asbestos Covered Magnet Wire is positively fire and moisture proof. We recover the wire in your old coils and rewind them or furnish new wire on reels or in coils.



Assembled Commutators and Bars

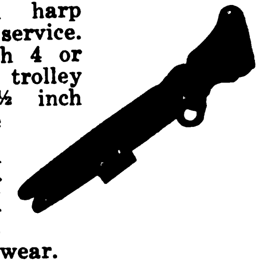


Dropforged, cast or drawn bars of Pure Lake copper, loose or assembled. Workmanship guaranteed to be of the best.

Mine Couplers

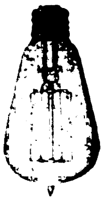
Of drop forged steel. Positively the best, safest and cheapest coupler on the market.

"Elreco" Trolley Harp



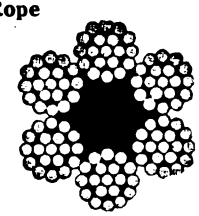
The ideal harp for mine service. For use with 4 or 4½ inch trolley wheel, ½x1½ inch bushing. We can furnish trolley wheels of special composition insuring long wear.

Tungsten and Carbon Lamps



"America" brand carbon lamps are well and favorably known amongst mining men. Our Tungsten lamps are very rugged and are being adopted by many mines. We recommend a trial.

Wire and Manilla Rope



Made by Waterbury. It has been our endeavor during the 19 years we have been serving the mining trade to furnish only the best. We will appreciate an opportunity to serve you.

GEE ELECTRIC COMPANY

Factory and Office

WHEELING, W. VA., U. S. A.

Manufacturers and Dealers

Electrical Supplies, Machinery and Repairs

Products

Overhead Line Material, Track Equipment, "Golden Glow" Mine Headlights, "Garton-Daniels" Lightning Arresters, Insulators, Cables, Telephones, Lighting Fixtures, Etc.

In addition, we operate a complete shop for the construction and repair of motors, generators, and all electrical machinery used about the mine.

Repair Department

In our shops we have complete facilities for the repairing and rebuilding of all makes and types of motors, dynamos, etc. The various departments of our shop are in charge of experienced men who are specialists in their line, and the work of these departments is coordinated so as to handle repairs with a maximum of dispatch and thoroughness.

We have on hand a large stock of rectangular and round magnet wire, commutator copper and insulating materials, some of which are practically off the market at this time.

Our tests are rigid, our work guaranteed.

Commutators

Complete commutators, and commutator segments with insulating material, assembled in sets, can be furnished for all mining and industrial types of motors.

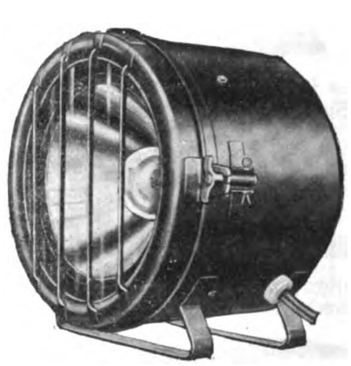
The insulation consists of the best grade of mica, which will wear down evenly with the copper. All assembled commutator segments are finished complete ready to mount on the shell. For the purpose of shipment they are bound with wire and held in position by temporary wood discs bolted through the center.

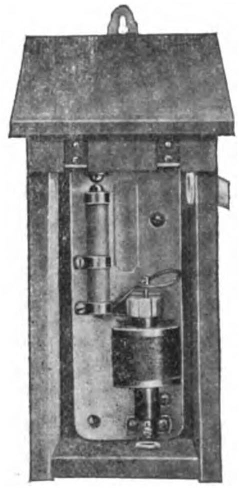
Complete commutators, or assembled segments for all standard motors, or for special types of motors will be furnished.

Golden Glow Headlights

Golden Glow Headlights are equipped with yellowish green reflectors, accurately ground, polished and silvered. The light, reflected from the mirrored surface is affected by the special glass so that there is projected a beam of golden yellow light which will penetrate fog, dust, and smoke to a much greater extent than is possible with a white light, and at the same time the dazzling and blinding effect of the white light is avoided.

The lamp is flexibly mounted in the case, which is of drawn steel, electrically welded. No castings are used. The lamp can be equipped with fixed or with swivel base.





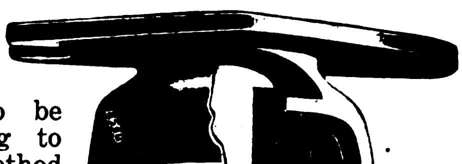
Garton-Daniels Lightning Arresters

Garton-Daniels Lightning Arresters are adapted for station, pole, car, or locomotive service, on direct or alternating current of voltages up to 6,000 volts. They offer practically a straight path of low resistance for lightning or static discharges direct to the ground connection which are uninterrupted except for an air gap varying with the voltage.

The flow of normal current is broken during a discharge by a solenoid circuit breaker which is practically instantaneous in its action. After opening the circuit the armature returns by gravity to its original position, making the arrester ready for the next discharge.

Keystone Overhead Trolley Material

Keystone overhead trolley wire supporting devices are of various types, designed to meet all possible conditions encountered in mine and industrial haulage systems. Suspensions are made in various forms to be used according to the required method of construction. The designs represent the result of many years experience in the manufacture of overhead line material for electrical railway use, as well as the ideas of the leading railroad and mining engineers.



A full description of this line will be found on pages 656 and 657. (E. S. S. Co.)

IRON CITY ELECTRIC CO.

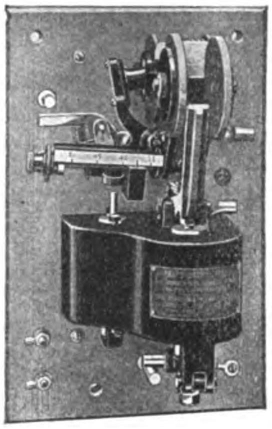
Electrical Supplies

PITTSBURGH, PA.

Products

We have a complete line of everything Electrical for the Mine and Shop, including Ammeters and Voltmeters; Batteries, all kinds; Mine Machine Cables; Carbons and Carbon Brushes; Circuit Breakers; Trolley Clamps; Conduits; Condulets; Controllers, D. C. and A. C.; Overhead Trolley Supplies; Dynamos and Motors; Electric Lamps, Arc and Incandescent; Mine Hangers; Electric Fans; Fibre; Flash Lights; Fuses; Electric Gongs; Heavy Hardware; Trolley Harps; Headlights; Insulators and Pins; Insulated Wire and Cable; Magnet Wire; Mine Telephones; Insulating Paints and Varnishes; Recording Instruments; Rheostats; Switches and Switchboards; Transformers; Trolley Wheels; Poles; Crouse-Hinds type R. M. Reflectors.

Automatic Circuit Breakers



Type "I" Automatic Reclosing Circuit Breakers were designed and developed primarily for individual motor protection, applicable to the protection of any form of industrial D. C. motors. They are built in 50 and 100 ampere capacities. The particular feature which distinguishes this breaker from other breakers ordinarily used for individual motor protection is the automatic reclosure upon the return of the starting box handle to the "off" position. This reclosure is automatic and instantaneous. Write us for prices and descriptive bulletins. **See page 664 for detailed description.**

Wires and Cable

Ansonia "Shield Brand" Weather-Proof, Fire and Weather-Proof and Slow Burning Wires and Cables; Annunciator, Damp-Proof Office and Magnet Wires.

If you have never used "Shield Brand" Wires and Cables, try it and allow us to prove to you that it is not merely a question of price per pound that interests you, but **Quality** as well. If Real Economy means anything to you, if Durability and Service are essentials, use "Shield Brand" Wires and Cables.

A large stock carried in our Pittsburgh warehouse.

Detroit Fused Switches

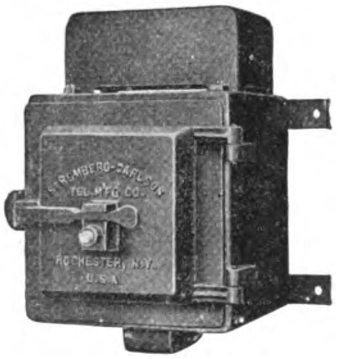
The Detroit Iron-Clad Fused Switch is the Original **"Safety First"** Switch put on the market. It has been designed to meet the most rigid requirements of safety devices for controlling electrical equipment of mines. No vital parts can be injured through exposure to water, gas fumes or dust, as it is constructed to withstand the most severe conditions found in mine installations.

Write for Bulletins giving fuller description.

Mine-A-Phone

The No. 890 Mine-A-Phone is the only **Real** mine telephone built to withstand conditions found in the mine. It is the result of a thorough and extensive study of mine conditions, and contains many features not found in any other makes. No other telephone so completely meets the needs of underground service.

For further particulars write us for your copy of Bulletin No. 1000.



No. 890 Mine-A-Phone Showing Plunger and Lock.

KESTER ELECTRIC CO.

TERRE HAUTE, IND.

Manufacturers of

Dynamos, Motors and Switch Boards
General Electrical Mine Supplies

Products.

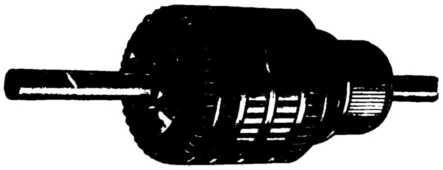
We manufacture armature coils, field coils, commutators, armature shafts, and brass castings, of all kinds. We rewind armature, field, induction and motor coils for all purposes, and specialize on secondhand machinery, all machinery is thoroughly overhauled and tested before leaving our shop. We repair all classes of machine or electrical equipments, used in or about a mine, also give special attention to elevator repair work.

General supplies carried in stock at all times: Lamps, arc and incadescent; bare and insulated wire, trolley fittings, trolley switches, general switchboard and cut-out switches; fuses of all types and sizes; carbon brushes.

Shop:

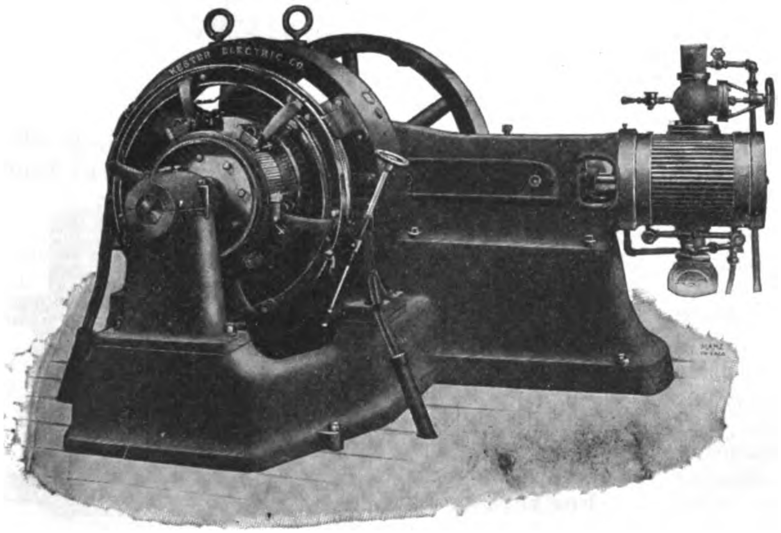
Kester Electric Co. is located 1000 to 1010 So. 14th St., Terre Haute, Indiana. Terre Haute, being located on three trunk lines, makes it one of the best shipping points in the central coal field. It gives advantage of getting freight back and forth with least possible delay.

We have manufactured electrical apparatus for the past 28 years and keep our shop filled with the most practical men in this line. We also furnish men for road work for engineing and erecting general construction.

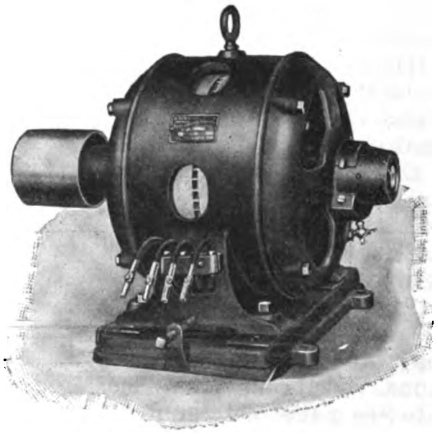


We specialize in armature rewinding.

We are in a position to furnish centrifugal pumps of any size or capacity that might be required, either engine or motor driven.



(Direct connected generator and engine).
Direct connected generator and engine, D. C. or A. C., furnished in all sizes from 5 to 500 K. W. Price upon application.



We are in position to furnish A. C. or D. C. motors from ½ to 500 H. P. Motors up to 50 H. P. carried in stock at all times. Prices upon application.

We pride ourselves on our efficient service and the number of satisfied customers.

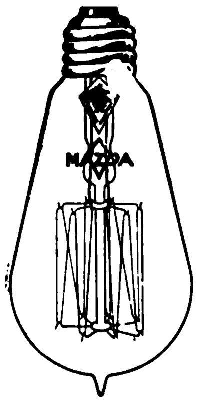
W. T. McCULLOUGH ELECTRIC CO.

PITTSBURGH, PA.

Electrical Supplies

A Partial List of Our Line

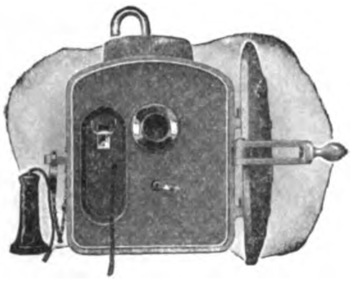
- Mine Hangers
- Expansion Bolts
- Trolley Splicers
- Mine Feed Wire Insulators
- Trolley Wheels
- Trolley Ears
- Trolley Frogs
- Section Insulators
- Strain Insulators
- Carbon Brushes
- Commutator Cement
- Friction Tape
- Knife Switches
- Telephones
- Lamp Guards
- Iron Conduit
- Wiring Devices of All Kinds
- Rubber Tape
- Safety Switches
- Telephone Supplies
- Panel Boards
- Condulets
- Peirce Specialties
- Lightning Arresters
- Gongs—Mechanical
- Gongs—Electrical
- Ever Ready Daylos
- Benjamin Reflectors
- Enclosed Fuses
- Refillable Fuses
- Carbon Lamps
- Mazda Lamps
- Insulating Material



Incandescent Lamps

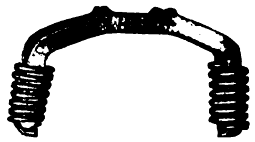
For Mine Service we particularly recommend our Duquesne Carbon Lamp. All voltages up to and including 300 volts carried in Pittsburgh; also a complete stock of Mazda Lamps.

Connecticut Weather-Proof Iron Box Telephones



These telephones are designed for mine use. This is a complete telephone with powerful generator, ringer, induction coil, transmitter, receiver, lightning arrester, etc., all parts of which have been specially treated to withstand weather conditions. Write for catalog for full details.

Peirce Mine Brackets

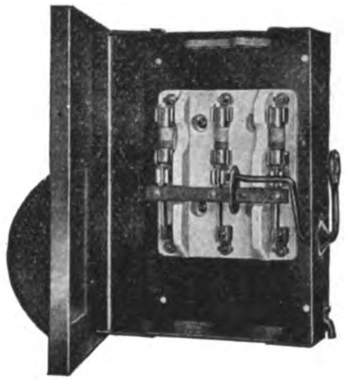


The Peirce Mine Brackets were developed for mine service. They are attached in position shown, by means of Lag Screws or Hanger Screws. We also carry a complete line of all Peirce Specialties.

Insulating Materials

We would particularly call your attention to our stock of Insulating Materials for all kinds of repair work.

Mica
Fibre Board
Fibre Rods
Fibre Tubes
Insulating Paint
Insulating Varnish
Linen Tapes
Varnished Cloth
Linotapes
Cotton Sleeving
Insulating Papers of all kinds.



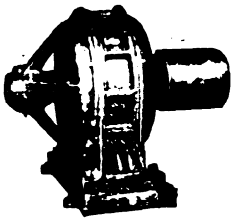
Safety Switches

We carry a line of Safety Switches in Pittsburgh stock to meet all requirements; also a complete line of standard Knife switches.

THE W. G. NAGEL ELECTRIC CO.

28-32 St. Clair St.
TOLEDO, OHIO

Electrical Machinery and Supplies



WE BUY, SELL, RENT, EXCHANGE AND REPAIR ALL SIZES AND MAKES OF ELECTRIC MOTORS AND GENERATORS.

We have available for immediate delivery a complete stock of motors, sizes ½ to 150 H. P.

Also complete line of Electric Supplies and Wiring Devices, Switchboards, Storage Batteries, etc.

Guaranteed Electrical Repair Work

This is a part of our business to which we give particular attention. We maintain a large department and employ skilled workmen for the repair of electrical equipment of all kinds. Our charges are reasonable and work strictly high-grade.

In case of breakdown, we can render specially prompt service, by 24-hour-a- day work, or can furnish another machine for use temporarily.

ARMATURES, FIELD COILS AND STATORS REWOUND, NEW COMMUTATORS FURNISHED, ETC.

NAGEL MOTOR LIST

REAL BARGAINS IN
NEW and RE-MANUFACTURED

Motors and Generators

READY TO SHIP

THE W. G. NAGEL ELECTRIC CO.
TOLEDO, OHIO

YOU NEED
THIS BOOKLET!

If you are a User of Electric Motors or a Manufacturer marketing Motor Driven Machines, this little Monthly Booklet will interest you.

It contains description and prices on a large stock of motors—sizes ½ to 150 H. P., which we can ship **immediately from stock**—motors which cannot be procured from the factory in less than six months.

Our Motor List No. 22 is just out! Ask for a copy and we will mail Booklet to you monthly.

WE WANT TO BUY MOTORS AS WELL AS TO SELL. WHAT HAVE YOU AVAILABLE?

Our No. 9 Supply Catalog

If you are a user of Electrical Supplies and do not have this book, ask for your copy.

We carry in stock a complete line of Electrical Power and Lighting Supplies, and can furnish for prompt delivery everything needed for an Electrical Installation.

LARGE STOCK

QUICK DELIVERIES

REASONABLE PRICES

THE POST-GLOVER ELECTRIC CO.

314 - 316 West Fourth Street,
CINCINNATI, OHIO

Manufacturers of

Electrical Accessories

Products

Mining Machine and Locomotive Cable; Bare, Weatherproof, Rubber Covered and Magnet Wires; Dry Batteries; "Eveready" Storage Batteries; P-G Friction and Rubber Hydro-proof and P. & B. Weatherproof Tape; Trolley Clamps, Hangers, and other Overhead Line Materials; Trolley Harps; Insulating Varnishes, Paints, cloths, and Tapes; Noark Standard and "Economy Renewable" Fuses; Buckeye Mazda and Carbon Filament Lamps; Emerson Exhaust Ventilating Fans; A. C. and D. C. Fans; A. C. and D. C. Motors.

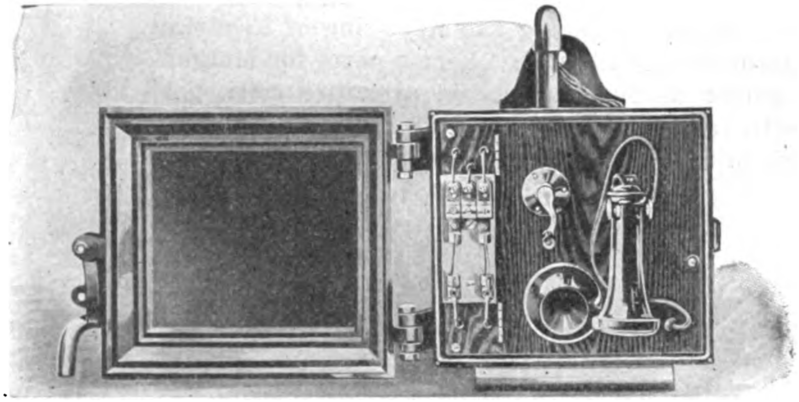
Mining Machine Cable

The Mining Machine Cable shown in the illustration is constructed of high grade pure copper strands, each strand being composed of 7 strands of fine, flexible wires. The conductors are separately covered with the best grade para rubber, then laid side by side and covered with four woven canvas coatings and the whole covered by a good weather-proof insulating varnish.

Enclosed Cartridge Fuses

As well as the well known "NOARK" Enclosed Fuse shown, we carry a full line of "Economy" Renewable Fuses in full capacity ranges in all the standard voltages.

"Economy" Renewable Fuses save 4/5 in cost, are uniformly rated, never vent fire or hold a sustained arc.



P-G Safety First Mine Telephones

Are weather tight and moisture proof. The coils of the generator and ringer are specially treated to resist moisture and gases. The parts are of non-corrosive metals, the whole phone is enclosed in a tight iron box, enameled and japaned to make it rust-proof. Can be attached to straight or curved surface.

Lighting Fixtures

Complete Gas and Electric Lighing Fixtures and accessories carried in stock. We are prepared to take care of any and all kinds of work, whether it calls for special or standard fixtures.

Switch Boards

Our switch board factory is fully squipped to take care of your requirements in the way of Panel, Distributing and Switchboard Construction.

Shipments

Our reputation for shipment of goods on the same day that orders are recived is universally known wherever electrical supplies are required.

Send us your inquiries for anything **electrical.**

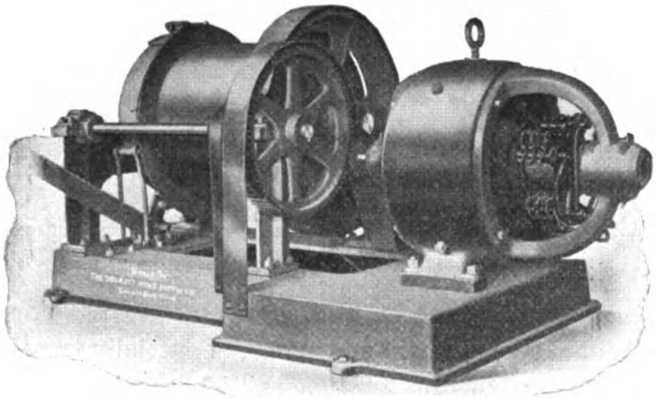
THE SACKETT MINE SUPPLY CO.

Main Office and Factory, Columbus, Ohio
SALES OFFICE, WELCH, W. VA.
Supplies for Morgan-Gardner Machinery.
General Electric Motors, Skinner Engines

Electrical Construction, Supplies and Repairs

Products

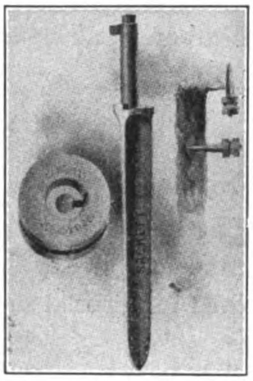
Electric Hoists, Mine Fans, Line Material, Insulators, Trolley Wheels, Trolley Harps, Armature Rewinding, Rebuilding and Repairing of Electrical Machinery; Machinists. Repair parts for Morgan-Gardner mining machinery, armature coils, field coils, commutators, rebuilt mining machines, electric mine locomotives and stationary motors.



"Sackett" Single Drum Electric Hoists. Sizes 5 H. P. to 60 H. P. Send for "Pamphlet R."

Sackett Type "A" Insulator

An improved device for supporting feed wires in Coal Mines. Consists of malleable iron pin and white vitrified porcelain knob. Is self-draining, has no springs, washers or other small parts, is easily put up and taken down. The porcelain knob locks securely on the pin which is 8½ in. long. The knob is 2½x2 in, with ¾ in. groove—large enough for 4-0 bare wire or cable. Total weight 1¼ lbs. Ask your dealer.



Sackett "Heavy" Type" Trolley Wheel

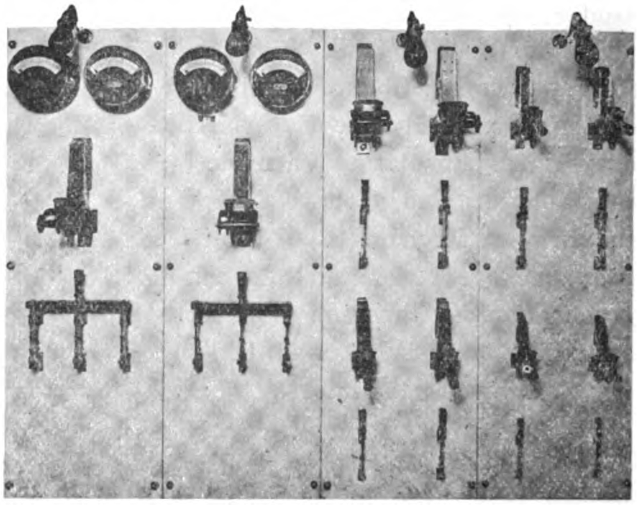
These wheels will out-wear three of the ordinary wheels and the rims cannot be cut or worn off.

Mine Fans

Either belt driven or direct connected to motors. Put your ventilation problems up to us.

We Build Switch-Boards

for every condition of power and lighting service for coal mines and factories. Over 1,000 panels have been built by us for coal mining plants.



Motors and Controllers

We supply a large number of different forms of motors and controllers to meet the varied requirements of coal mine and factory service, both direct and alternating current motors for belted, geared, silent chain or direct connected drives for continuous or intermittent load, constant or variable speed.

We will be pleased to supply engineering data and recommendations as to the type and form of motor best adapted to customers' conditions.

Electrical Repairs

Our plant, which covers 22,500 square feet of floor space, contains a finely equipped Rewinding Shop, and Machine Shop, with every facility for repairing or re-building Mining Machinery. Quick service, good workmanship and reasonable prices guaranteed.

Screen Bars and Bearing Bars in stock.

We Rewind and Rebuild All Types and Classes of Electrical Machinery and Equipment.

UNION ELECTRIC COMPANY

Electrical Headquarters

PITTSBURGH, PA.

The following is a partial list of articles carried by us in stock—insuring rapid delivery on every requisite for the mine.

Products

Mine Locomotive Headlights,
Gears and Pinions,
Mine Locomotive Trolleys,
Mine Hangers,
Expansion Bolts,
Trolley Splicers,
Trolley Crossings,
Electric Rock Drills,
Bow-arrow Cross Arms,
Insulating Paints,
Babbitt Metal,
Commutator Cement,
Track Drills,
Jacks,
Mine Feed Wire Insulators,
Electric Mine Lamp Bulbs,
Carbon Brushes,
Trolley Pole Heads and Harps,
Trolley Wheels,
Flexible Couplings,
Clamping Ears,
Trolley Frogs,
Section Insulators,
Peirce Specialties,
Lightning Arrestors,
Bond Testers,
Automatic Cable Clamps,
Third Rail Insulators,
Gongs,
Eveready Flashlights,
Ivanhoe Steel Reflectors,
Rail Bonds,
General Wiring and Lighting Supplies.

Nuttall Gears, Pinions, Trolleys and Trolley Parts

Nuttall Gears and Pinions for haulage locomotives, mining machines, pumps,—in fact, gearing of any standard or special design. See full page adv. on page 512.

General Electric Railbonds and Overhead Line Material.

Quality established and prices right; railbonds for every condition—either pin driven or solid terminals. Our new type combination low mine hangers will take care of installations in coal, on timber or on pipe brackets by using with it our expansion bolts, hanger lag screws or combination pipe clamps. Our mechanical Trolley Clamp is far better than any other type. Write for descriptive bulletin or samples.

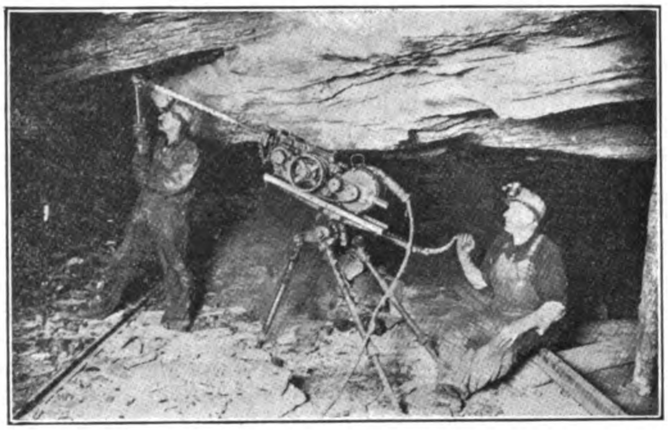
See full page adv. on page 661.

Crouse-Hinds Headlights

Arc, Incandescent, and Luminous. Write for literature on later types of Luminous Headlights. Furnished on trial basis.

General Supplies

Our stocks are complete in every particular—and our claim to "electrical headquarters" is proven by the service we render.



Fort Wayne Electric Rock Drill

This type of drill is being used by a great number of mine owners and is considered the standard. The expense of maintenance and current consumption are both very low and it will prove satisfactory in any rock encountered in a coal mine. Communicate with us if you have any rock faults and we will demonstrate its superiority over any other make of drill on the market. Write for testimonial letters and bulletin. See full page adv. on page 625.

Insulating Material for Repair Work

A large stock of all kinds of insulating material is carried by us. Send for our "Insulating Paint and Varnish" catalog which shows the proper paint or varnish to be used for all classes of insulating work.

WESTERN ELECTRIC COMPANY

INCORPORATED

NEW YORK
BUFFALO
NEWARK
PHILADELPHIA
BOSTON
ATLANTA
RICHMOND
SAVANNAH
NEW ORLEANS
BIRMINGHAM
CHICAGO
MILWAUKEE
INDIANAPOLIS
DETROIT
CLEVELAND
KANSAS CITY
ST. LOUIS
DALLAS
HOUSTON
OKLAHOMA CITY
SAN FRANCISCO
OAKLAND
LOS ANGELES
SEATTLE
PORTLAND
PITTSBURGH CINCINNATI MINNEAPOLIS ST. PAUL OMAHA DENVER SALT LAKE CITY

Equipment for Every Electrical Need

Western Electric

Mine Supplies

General

The Western Electric Company is prepared to furnish equipment for every electrical need in the mine. Ample stocks are constantly maintained at each of our distributing houses to give customers the best possible service. We are emergency specialists.

The following are some of the complete lines carried. They are the best of their kind. The name Western Electric guarantees their high quality.

Car Parts

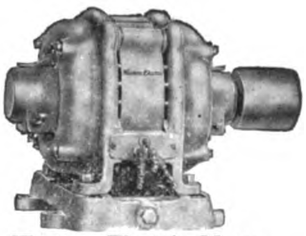
This line includes standard Shelby trolley poles, trolley harps, Kalamazoo trolley wheels and harps, head lights, lamps, circuit breakers, rheostats, commutator parts, Samson cordage, brushes and brush holders.

All car parts are designed and built for long service. Their use insures low maintenance costs.

Commutators.

Motors

Direct and alternating current electric motors are available for every phase of mine work—for cars, hoists, pumps, crushers and exhaust fans. They are built under the most comprehensive specifications and every step in manufacture is conducted under rigid inspections. Western Electric motors require only a minimum of maintenance for maximum service.



Western Electric Motor

Overhead Materials

Under this head are included frogs, suspension clamps, insulators, trolley ears and everything else for the line—all of the best.

Reel Cable

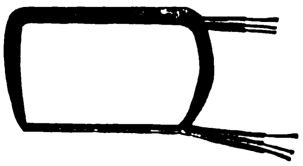
For mine locomotives, Western Electric reel cable will be found to have a life many times longer than the ordinary commercial cable. This is due to the special linen braid covering the flexible conductors.

Magnet Wire

Enamel coated, cotton or silk covered magnet wire of high conductiviy is carried in stock in large quantities. This wire will meet all ordinary requirements satisfactorily.

Deltabeston Magnet Wire

This is a flexible, fire and moisture proof wire particularly adapted to field and armature coil winding. The insulation is an asbestos composition which adapts it for use where overloads are frequent and severe. Square and rectangular Deltabeston wire makes it possible to put a greater cross-section of copper into a given winding space than is possible with round conductors.



Deltabeston Armature Coil.

Mining Machine Cable

Duplex mining machine cable consists of flexible strands, rubber insulated. Each conductor is finished with a waterproof braid. Two conductors are then laid parallel and covered with two or three braids of hard cotton, which is then thoroughly waterproofed.

D. & W. Fuses

These fuses are designed for accuracy and safety. They meet every requirement of the National Electric Code and can be relied upon to withstand great mechanical strains and the severest electrical conditions.

Mica

Both cut and uncut mica of the highest grade can be furnished for insulating purposes. The line of mica includes micanite commutator insulation and rings, micanite plates for molding into any desired shape and flexible micanite plates.

Insulating Cloths, Papers and Varnishes

These materials include oiled cloth, linen, silk, tapes and paper in which the cloths and paper serve as a carrier for the insulating oil. The oil when dried provides an insulating substance of great strength, flexibility, long life and high resistance to heat and electricity.

The line of insulating varnishes includes air drying and baking varnishes of every description. They are durable and have excellent insulating properties.

Graphite Lubricating Bushings

For insuring oil-less lubrication, the line of "Bound Brook" bushings will be found most efficient.

WESTERN ELECTRIC COMPANY

INCORPORATED

NEW YORK
BUFFALO
NEWARK
PHILADELPHIA
BOSTON
PITTSBURGH
ATLANTA
RICHMOND
SAVANNAH
NEW ORLEANS
BIRMINGHAM
CINCINNATI
CHICAGO
MILWAUKEE
INDIANAPOLIS
DETROIT
CLEVELAND
MINNEAPOLIS
ST. PAUL
KANSAS CITY
ST. LOUIS
DALLAS
HOUSTON
OKLAHOMA CITY
OMAHA
DENVER
SAN FRANCISCO
OAKLAND
LOS ANGELES
SEATTLE
PORTLAND
SALT LAKE CITY

Equipment for Every Electrical Need

Western Electric

Mine Supplies

Tapes

Western Electric Tape is of the highest quality. The basis is an unbleached sheeting selected for strength and durability. It is impregnated with a preservative and insulating compound that will successfully withstand severe atmospheric conditions.

It is particularly adapted to conditions of mine service in that it is repellent to moisture. It is actually rain proof. These qualities make it exceedingly desirable for mine work, above and underground. There are two grades made, known as Western Electric Amazon and Western Electric Victor Tapes, respectively.

The former is recommended for insulation on armature windings, field coils and line work requiring friction tape of superior quality.

The Victor quality is an excellent tape that meets all requirements of ordinary electric lighting circuits.

The tapes contain no free sulphur and therefore cannot corrode copper wire. Their insulating properties are high.

They do not unwrap or dry out. Their adhesive qualities are excellent.

Golden Glow Headlights

Golden Glow incandescent headlights provide maximum illumination under all conditions that are encountered in mining service. Current consumption and upkeep cost are both unusually low. This produces the most efficient form of mine locomotive headlight.

Type ML-74—Closed.

The light is of a golden-yellow color, a color that is best adapted for projection in powerful concentrated beams. This is due to the fact that it contains none of the rays that produce the blinding portion of light.

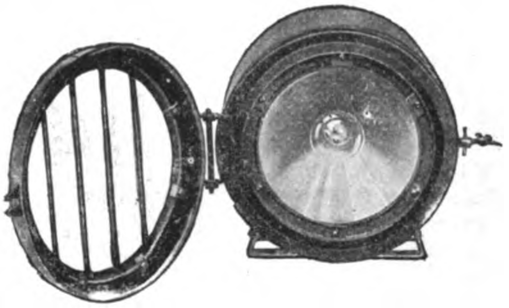
This light will also disclose much greater detail at a given distance than white light of equal intensity.

The Golden Glow light is produced by the special reflectors of greenish yellow glass formed, ground, polished and mirrored by patented machinery. This type of reflector is superior to other forms. Polished metal and enameled reflectors deteriorate; the former through oxidation or tarnishing, as well as scratching that results from attempts at cleaning.

The latter type deteriorates from discoloration and peeling.

The type of headlight illustrated has reflector and socket flexibly suspended in the case to prevent the vibration of the mine locomotive from breaking the lamp filament.

The case and all metal parts are of drawn steel, electrically welded, and finished inside and out in baked black enamel. No castings.



Type ML-74—Open.

The door is provided with a front grid to protect the front glass.

Headlight equipments can be furnished for single or double end use to burn either headlight singly or both at the same time.

Low operating costs with high efficiency of illumination are obtained by the use of 23 or 36 watt concentrated filament Mazda lamps.

Flood Lamps

Western Electric-Davis Flood Lamps are recommended for use above ground. They produce real "electric daylight."

Portable Type.

Whenever there is a new tipple that has to be rushed to a finish to meet increased tonnage; whenever there is an emergency that means night work at the shaft opening; whenever supplies and timber have to be loaded for underground at night—these high efficiency lamps will produce big savings in time and money for a comparatively small investment.

Two types—portable and bracket, the latter for mounting on poles—are available. As no permanent wiring is necessary, the lamps can be put in service quickly. The portable type can be easily carried from place to place wherever they may be needed.

The lamps may be arranged for diffusing the light over large areas or concentrating it in a solid beam by means of interchangeable reflectors. There is no glare.

The lamps are rugged in construction. The front glass is wired and cut into strips to permit expansion and contraction. Send for descriptive pamphlet.

Catalogs

Catalog matter describing Western Electric Quality Products will be sent upon request

DOUBLEDAY-HILL ELECTRIC CO.

MAIN OFFICES
PITTSBURGH, PA.
719-21 LIBERTY AVE.

Southern Branch
WASHINGTON, D. C.
715 12th ST., N. W.

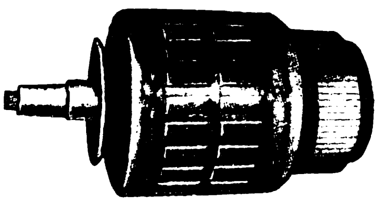
WE REPAIR: ALL MAKES, MOTORS, DYNAMOS, MAGNETOS, STORAGE BATTERIES, AUTOMOBILE GENERATORS, ELECTRIC FANS, ETC.

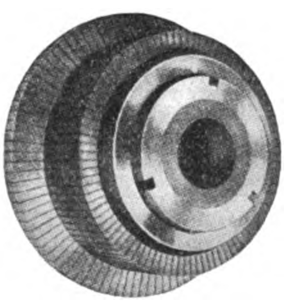
WE MANUFACTURE: ARMATURE COILS, FIELD COILS, AND COMMUTATORS.

Motors
Dynamos
Commutators
Field Coils
Armature Coils
Mine Supplies
Line Materials
Switches
Meters
Trolley Wheels
Electrical Driven Tools
Construction Tools
Klaxon Horns
Lamps
Mine Hangers
Bosch Magnetos
Gould Batteries
Flashlights
Brake Lining
Pierce Specialties
Carbon Brushes
Magnet Wire
Insulating Varnishes
Commutator Cement
Insulating Materials
Electric Fans

Armature Winding

We rewind armatures of all types, large or small, and our work will stand up under heavy duty. All armatures are vacuum impregnated with insuplastic varnish which never hardens enough to crack or scale when motor is subjected to vibration.





Commutators

Our commutators are built of best copper and mica, and are assembled under hydraulic pressure. The mica is of special quality and will wear at the same rate as the copper, thus doing away with high mica troubles.

Armature and Field Coils

We manufacture armature and field coils for all motors and generators. Our coils equal the factory product in every way, and our prices are much lower. All Coils are vacuum impregnated with insuplastic varnish.

This illustration shows the condition of old burned out field coils as received by us.

Heat Proof Coils

We use Salamander heat-proof wire in making armature and field coils. Asbestos insulation is used throughout. Give them a trial on your motors where burn-outs occur frequently from heavy duty.

New Field Coils Made From Old

Look over your scrap pile and pick out the field coils made of No. 6, or larger wire (or strap). Send them to us and we will remove the old insulation from the wire, tape the wire from end to end with linen tape, and rewind them to former shape, tape and impregnate them, and return them to you better than when new, and this costs you about one-half the factory price for new coils.

Alternating Current Motors

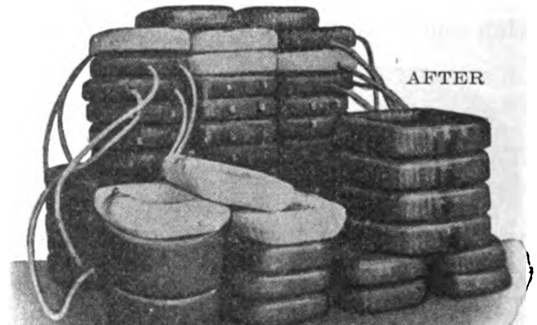
We rewind all types alternating current motors and generators.

Guarantee

All repair work, coils and commutators are guaranteed to be equal to factory product.

Automobile Service Station

Our Service Station at 5952 Baum Boulevard, Pittsburgh, is equipped to repair all makes of magnetos, generators, starters and batteries. We are distributors of Bosch Magnetos and Gould Storage Batteries.



This view shows the same coils after we have removed the old insulation, reinsulated the wire and rewound and finished it into same type of coil.

DUDLEY ELECTRIC & MACHINE CO.

Successors to
Uniontown Iron Works and Electric Company and Brownsville Electric Machine Company

Main Office and Shop:
UNIONTOWN, PA.

Branches:
BROWNSVILLE, PA.
CLARKSBURG, W. VA.

"We Never Sleep"

Electrical and Mechanical Repairs and Supplies

Products

We Manufacture Armature Coils; Armature Shafts; Commutators; Brass Castings; Special Machinery and repair parts.

We Wind Armatures; Fields; Induction Motors and Coils for all purposes.

We Repair Boilers, Engines, Air Compressors, Pumps and Machinery of all kinds.

. **We Furnish** and Install Power Plants; Hoisting, Haulage and Stationary Motors; New and second hand.

Second Hand Machinery

We specialize in second hand machinery. Machinery not being used for any reason, as renewals, replacements, dismantled plants, from forced sales, etc., will be bid for and bought by us at the highest price. In preparing them for resale all machines are thoroughly overhauled, new parts substituted where necessary, and tested completely before leaving our factory.

All work guaranteed.

Our Organization

is composed of men who are experts in their particular lines. It has always been the policy of this Company to secure and retain at any cost men whose experience in and about electrically operated mines render them especially capable of handling this class of work; by this means we have built up a highly efficient organization.

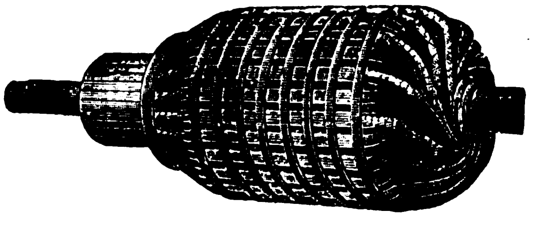
Location

Our main shop, at Uniontown, is located close to the several freight stations and express offices, and we have ideal facilities for handling heavy shipments, while our branch shops at Brownsville, Pa., and Clarksburg, W. Va., are maintained for the purpose of taking care of emergency work in their immediate localities.

Equipment

Our claim of superiority in this respect is based upon the fact that we have, in connection with our Electrical Repair Department, a modern Machine Shop equipped with machinery especially adapted for the work as outlined above, together with Blacksmith Shop, Acetylene Welding Apparatus, and Brass Foundry, including a modern tilting furnace, which enables us to get out Brass Castings to your orders on short notice.

Our Electric Department is equipped with the very latest machinery for the manufacturing of Armature Coils and Commutators. A Hydraulic Press for renewing armature shafts, locomotive axles, etc., while our methods of testing, treating and baking electrical apparatus; the results of a series of systematic experiments, based on observations through many years experience in and about mines, are best calculated to prolong the life and increase the efficiency of such apparatus when operating in damp, dusty and greasy places, and when subject to the severe duty which is quite frequently met with in mining operations.



Policy and Service

Our success is largely due to the fact that we have always maintained a policy of standing back of our work and seeing to it, that it gives service which is entirely satisfactory, although it may involve going beyond the terms of our liberal guarantee. Realizing fully the necessity of promptness in handling work of this kind we have arrangements, whereby we can work straight through night and day on break down and emergency jobs, and in addition to this we carry in stock a large assortment of armature coils, shafts, commutators, and other parts for standard machines, by means of which we are able to get work out very promptly.

We solicit your inquiries, welcome suggestions, invite criticism, and assure you that any and all correspondence will receive prompt and courteous attention.

THE ELECTRIC SERVICE CO., Inc.

212 Walnut Street, Cincinnati, Ohio

Electrical Repairs
New and Rebuilt Electrical Machinery

Products

Rewinding and rebuilding of electrical machinery. Specialists in heavy and difficult repairs.

Armature and Field Coils, new and reinsulated.

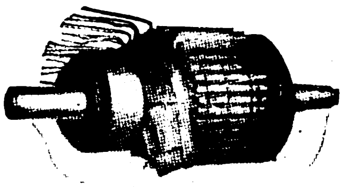
Repairers of Transformers and Manufacturers of Switchboards, etc.

Engineering

We have had twenty-six years of experience, both technical and practical, and are specializing and catering to the coal mining trade, and are prepared to do the heaviest and most difficult work, either in our shop, or at the mines or power plant. We have sent men to the mines to change the voltage from 550 volts to 250 volts. The men in our employ are particularly skilled along these lines, as evidenced by the New River Company letter which you will find reproduced below.

The few letters at the bottom of this page will give you an idea of what the people we work for think of us.

Repairing

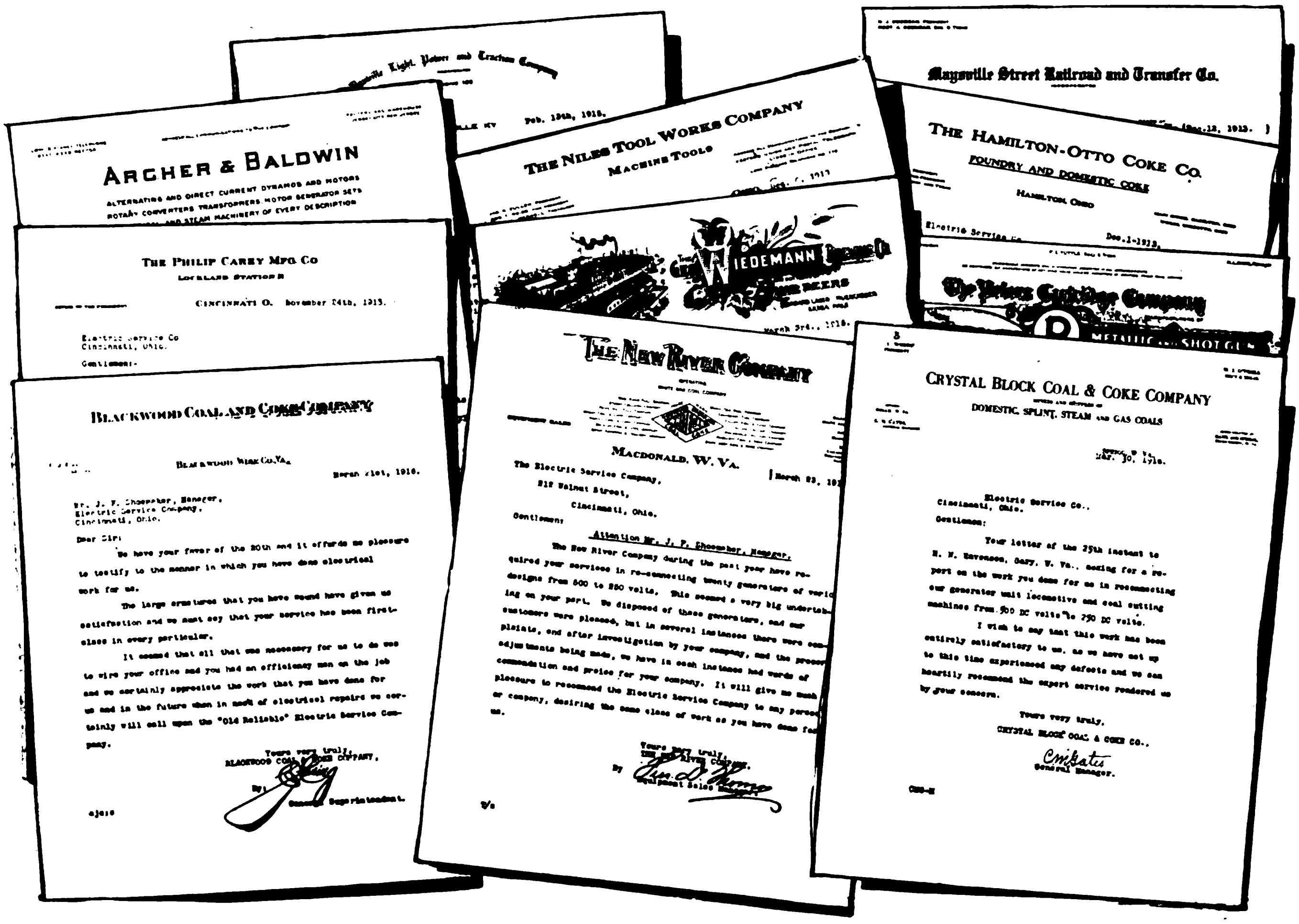


We have the largest and best equipped Repair Shop in the Middle West, and are particularly equipped to wind any class of armature or field coils, and to reinsulate and treat coils for all mining purposes; to repair and rewind transformers; in fact, any type of electrical mining repairs. All work done at our shop guaranteed in writing to be correct in every respect.

New and Second Hand Machinery

We carry a large, complete stock of new and rebuilt electrical machinery of all classes. All used machines sold by us are guaranteed to be O. K. in every respect, and we can save purchasers considerable money over the cost of new machinery.

Best of reference furnished.



Light, Power and Traction Company

Feb. 19th, 1916.

ARCHER & BALDWIN

ALTERNATING AND DIRECT CURRENT DYNAMOS AND MOTORS
TRANSFORMERS MOTOR GENERATOR SETS
ROTARY CONVERTERS ... AND STEAM MACHINERY OF EVERY DESCRIPTION

THE NILES TOOL WORKS COMPANY

MACHINE TOOLS

Maysville Street Railroad and Transfer Co.

THE HAMILTON-OTTO COKE CO.

FOUNDRY AND DOMESTIC COKE

HAMILTON, OHIO

Electric Service Co

Dec. 1-1913.

WIEDEMANN

BEERS

March 3rd., 1916.

METALLIC AND SHOTGUN

THE PHILIP CAREY MFG. CO.

LOCKLAND STATION B

CINCINNATI O. November 24th, 1913.

Electric Service Co
Cincinnati, Ohio.

Gentlemen:-

BLACKWOOD COAL AND COKE COMPANY

BLACKWOOD, WISE CO., VA.

March 21st, 1916.

Mr. J. F. Shoemaker, Manager,
Electric Service Company,
Cincinnati, Ohio.

Dear Sir:

We have your favor of the 20th and it affords me pleasure to testify to the manner in which you have done electrical work for us.

The large armatures that you have wound have given us satisfaction and we must say that your service has been first-class in every particular.

It seemed that all that was necessary for us to do was to wire your office and you had an efficiency man on the job and we certainly appreciate the work that you have done for us and in the future when in need of electrical repairs we certainly will call upon the "Old Reliable" Electric Service Company.

Yours very truly,
BLACKWOOD COAL & COKE COMPANY,
By: General Superintendent.

THE NEW RIVER COMPANY

MACDONALD, W. VA.

March 23, 191

The Electric Service Company,
212 Walnut Street,
Cincinnati, Ohio.

Gentlemen:

Attention Mr. J. F. Shoemaker, Manager.

The New River Company during the past year have required your services in re-connecting twenty generators of vario designs from 500 to 250 volts. This seemed a very big undertaking on your part. We disposed of these generators, and our customers were pleased, but in several instances there were complaints, and after investigation by your company, and the proper adjustments being made, we have in each instance had words of commendation and praise for your company. It will give me much pleasure to recommend the Electric Service Company to any perso or company, desiring the same class of work as you have done fo us.

Yours very truly,
THE NEW RIVER COMPANY,
By Equipment Sales Manager.

CRYSTAL BLOCK COAL & COKE COMPANY

DOMESTIC, SPLINT, STEAM AND GAS COALS

Mar. 30, 1916.

Electric Service Co.,
Cincinnati, Ohio.

Gentlemen:

Your letter of the 25th instant to H. N. Eavenson, Gary, W. Va., asking for a report on the work you done for us in reconnecting our generator unit locomotive and coal cutting machines from 500 DC volts to 250 DC volts.

I wish to say that this work has been entirely satisfactory to us, as we have not up to this time experienced any defects and we can heartily recommend the expert service rendered us by your concern.

Yours very truly,
CRYSTAL BLOCK COAL & COKE CO.,
C. M. Gates
General Manager.

Virginian Electric & Machine Works

CHARLESTON--KANAWHA, W. VA.

Manufacturer and Dealer

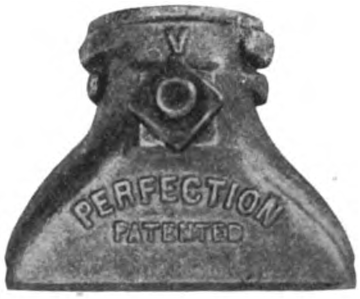
ELECTRICAL and MINING SUPPLIES

Products

Located in the heart of America's greatest Coal Mining District and recognized headquarters for the following:

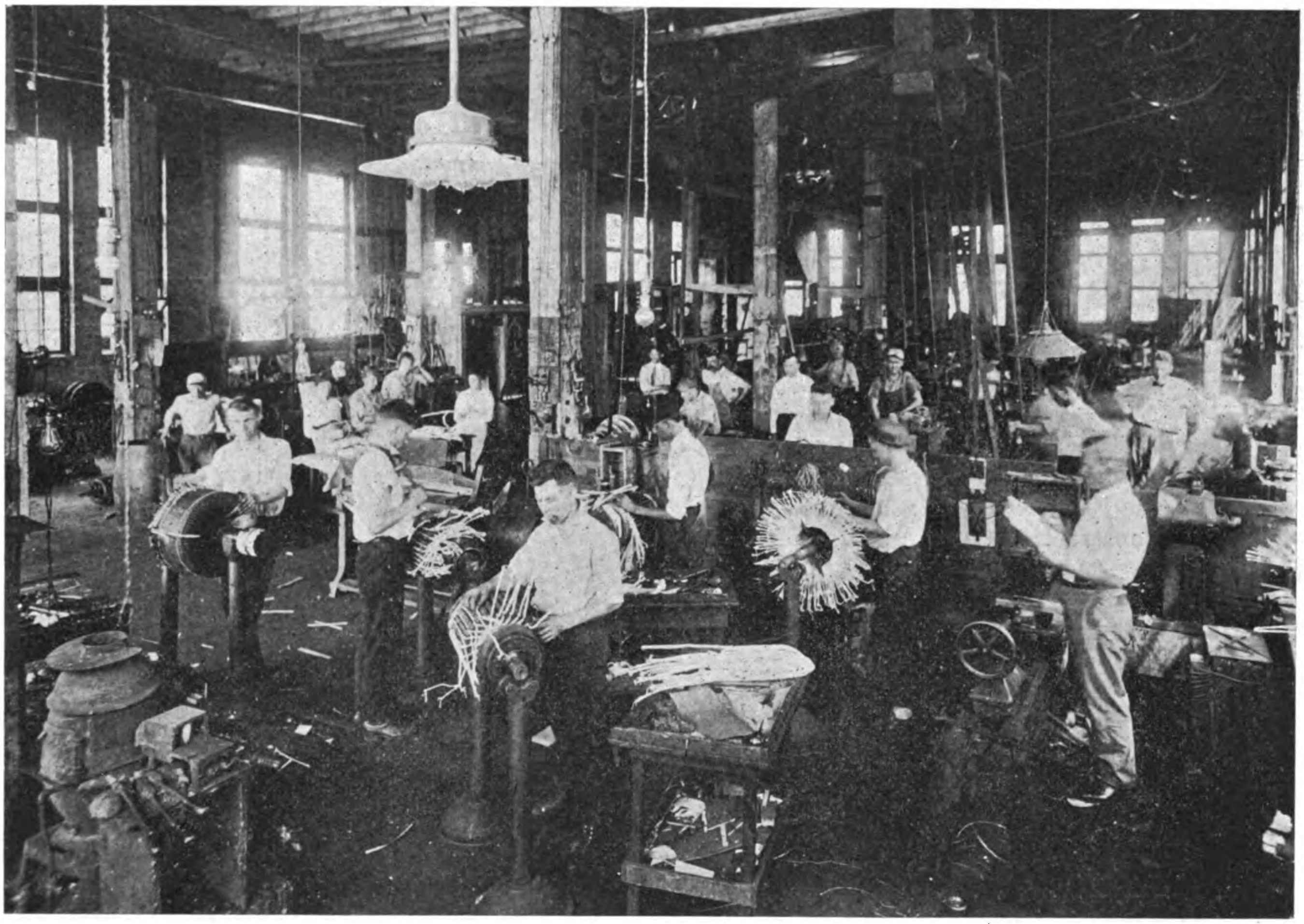
- Mine Locomotive Repairs
- Mine Locomotive Tires
- Locomotive Armature Work
- Axle Brasses
- Mine Machine Repair
- Armatures
- Armature Rewinding
- Rheostats
- Shafts
- Cutter Heads
- Trolley Wire
- Magnet Wire
- Insulated Wire and Cables
- Insulating Materials
- Tapes
- Shellac, Orange
- Mazda Lamps
- Carbon Lamps
- Asbestos
- Cutter Chain
- Cutter Chain Guides
- Sprockets
- Bushings
- Pinions
- Gears
- Commutators
- Commutator Compound
- Carbon Brushes
- Mine Machine Bits
- Overhead Material
- Switches
- Trolley Wheels
- Trolley Harps
- Babbit Metal
- Bronze
- Motors
- Motor Repairs
- Electrical Supplies.

Perfection Trolley Clamp



We are sole manufacturers of the Perfection Trolley Clamp illustrated above. A great number of these clamps are in service in various coal mines and are giving excellent and satisfactory results.

Get our quotation before placing your order.



Interior view showing Repair Department.

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING COMPANY INC.

REPAIRS,---NEW AND USED MACHINERY SECTION

The following dealers have catalogue descriptions in this section:

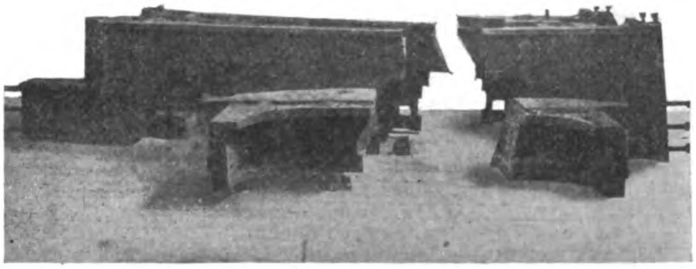
Beckwith Machinery Co.
Carlin, John H., Machine Co.
Duquesne Electric & Mfg. Co.
Front Construction Co.
McCoy-Brandt Machinery Co.
Miller-Owen Electric Co., Inc.
Pittsburgh Reinforced Brazing & Machine Co.
Winterer, Herman L.

For additional descriptions of Repairs,---New and Used Machinery, not appearing in this section, refer to Index of Products in front of book.

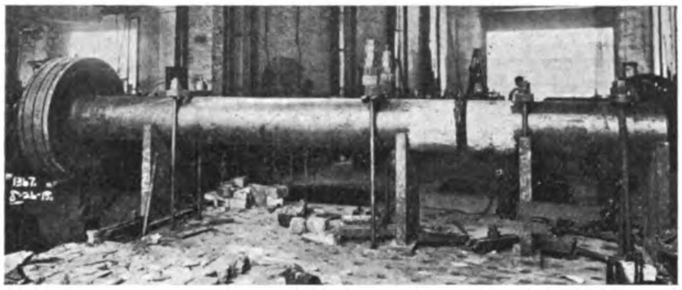
Pittsburgh Reinforced Brazing & Machine Co.

Office and Works:
2525 Liberty Ave., Pittsburgh, Pa.

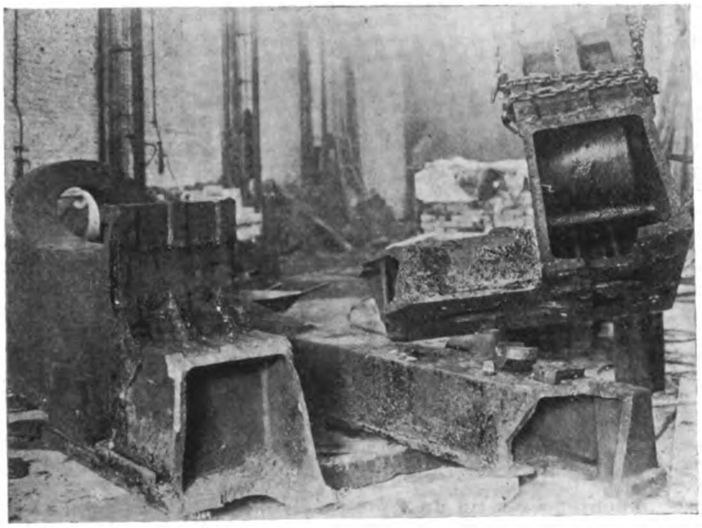
BRAZERS WELDERS AND GENERAL MACHINISTS



15-ton Mine Locomotive, Side **Frames and** Bumper.



10" Dia. Forged Steel Steam Hammer Piston Rod.



2500 H. P. Steam Engine Bed Plate.

Reinforced Brazing

is the method used whereby we can restore any heavy cast iron casting to its original strength, or in fact we can reinforce it to make it stronger at the point of fracture than it was originally.

Electric Mine Locomotive side frames, bumpers, gear wheels, etc., are permanently repaired in this manner.

Oxygen-Acetylene Welding

As used by us will restore to perfect condition gas engine, steam or compressor cylinders of any size or description, gear wheels, pumps, etc., and boiler repairs of any nature.

Thermit Welding

will restore to original strength and durability broken crank shafts, connecting rods, boat shafts or heavy steel castings of all kinds.

Electric Welding

is also employed by us extensively in the building up of worn spots in castings, forgings, etc., and plate welding.

By one of the above processes we can permanently restore to original strength any casting regardless of size, weight or metal.

BECKWITH MACHINERY CO.

Office, Warehouse and Yards

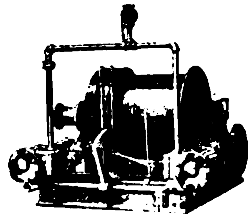
102-04-06-08-10 West Parkway, N. S., Pittsburgh, Pa

Construction Equipment

Delivered from Pittsburgh Stock

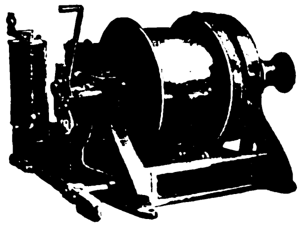
Products

Steam Hoists, Electric Hoists, Gasoline Hoists, Room Hoists, Derricks, Winches and Hand Hoists, Wire Rope, Vertical Boilers, Concrete Mixers, The Cement Gun, Emerson Pumps, Centrifugal Pumps, Hardscog Drills, Compressors, Wagon Loaders, Rapid Car Unloaders, Self-Dumping Buckets, Clam Shell Buckets, Wyoming Shovels, Fairbanks-Morse "Z" Engines.



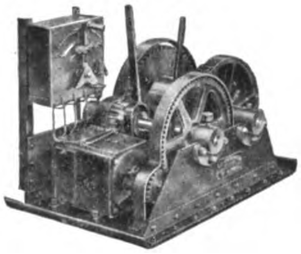
"Standard" Steam Hoists

Mead Morrison Hoists are designed for heavy service. Built in all sizes, single and double drum. Stocked in Pittsburgh up to 50 H. P.



Electric Hoists

Particularly adapted for high speed work—hauling cars on incline, skip or elevator hoist or small mine shaft. Built in a variety of sizes. The Standard Patent Friction Drum handles perfectly under any condition.



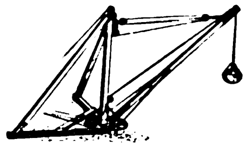
Portable "Room" Hoist

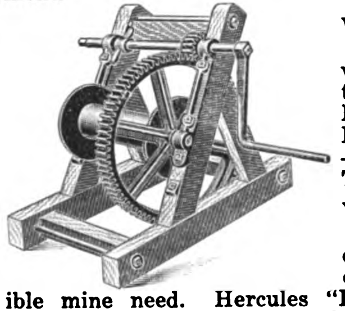
Light, compact and powerful; lends itself readily to the hauling problems peculiar to mines. Mounted on a steel skid, easily hauled over rough ground; useful at the entries, also about the tipple, 2 and 4 H. P.

Also Gasoline Hoists and Belt Driven Hoists.

Derricks

We construct Derricks; steel or timber of any description. Carrying a large stock of Derrick Fittings in Pittsburgh permits of prompt shipment.





Winches and Hand Powers

Single and double drum for wire or Manila rope. 500 lbs. to 10 ton capacities. Rope Blocks, Snatch Blocks, Rope, Rope Fixtures, Turnbuckles—complete equipment of Tackle.

Wire Rope

We have in stock a variety of wire rope extensive enough to meet every possible mine need. Hercules "Red Strand," Leschen Plow Steel, Cast Steel and special Steel Wire Ropes.

Clam Shell Buckets

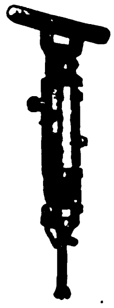
This Blaw type "C" Bucket handles to advantage sand in any condition, gravel, crushed stone, anthracite coal, bituminous coal, cinders and slag—from cars, boats or stock piles.

Self Dumping Bucket

Biehl Buckets are built to withstand the roughest usage. False bottoms, heavy bales and large trunions take big overloads. Self-Dumping and Self-Righting. Types and sizes to meet every need.

Emerson Pumps

For ditching, shaft sinking, foundations, etc. Requires no attention, no lubrication—positive action, throws a steady stream, never water-hammers. Handles water containing mud, sand and gravel. Requires no foundation, no priming; operates at any angle, economical in steam consumption.

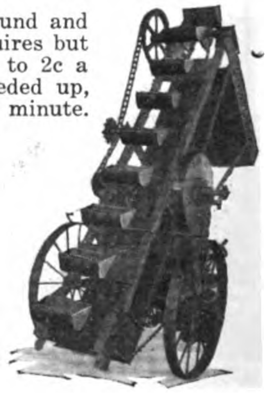


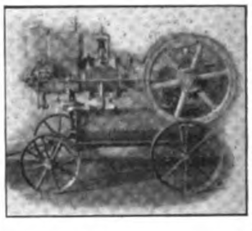
Hardscog Wonder Drill

Replace one drill of heavier make with two Hardscogs and on the same air consumption you **double** the number of feet of drilling in 12 ft. holes. In 6 ft. holes use 3 or 4 Hardscogs without increasing air consumption. Light in weight; only one moving part; durability proved by years of use.

Gifford Wagon Loaders

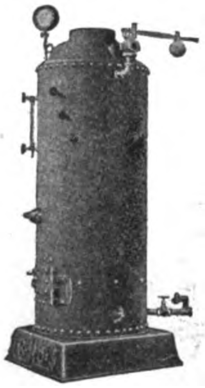
Picks up material from the ground and loads it directly into wagons. Requires but one attendant, handles coal at 1½ to 2c a ton; loads 1 ton every 2 minutes—speeded up, it has loaded and screened a ton a minute.





Quincy Gasoline Driven Compressors

Built in sizes from 30 to 160 cu. ft. These machines are remarkable time savers—especially when used with the Hardscog Drills.



Vertical Boilers

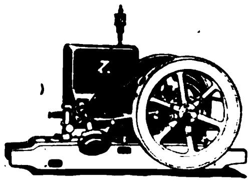
Our stock includes Boilers from 5 to 60 H. P. that meet the requirements of the new Ohio and Pennsylvania law.

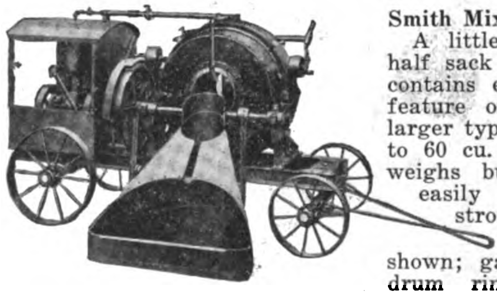
Wyoming Shovels

The "Red Edge" is a shovel of hard, tough steel—almost wearproof. Outlasts three ordinary shovels. The booklet, "Scientific Shoveling," saves money.

Fairbanks-Morse "Z" Engines

Run on common kerosene. Reliable as gasoline. High tension magneto; no batteries, no spark coil. The ideal, economical small power unit. 1½, 3 and 6 H. P.





Smith Mixerette

A little mixer, one-half sack capacity, that contains every essential feature of any of the larger types. Handles 50 to 60 cu. yds. per day, weighs but 2500 lbs..; easily portable, yet strong and durable. Mounted as shown; gasoline power; drum ring, gear and pinion enclosed in dust proof oil filled casing.

Large Capacity Steam Driven Smith Mixers also carried in stock.

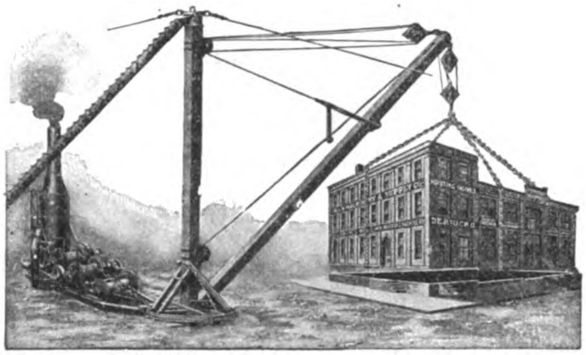
Delivered from Pittsburgh Stock.

JOHN H. CARLIN MACHINE CO.

Sandusky-Lacock Sts.
PITTSBURGH, PA.

Phone—Cedar 233
Night Phones
Mr. J. H. Carlin—Hiland 967
Mr. C. S. Schofield—Walnut 253-M

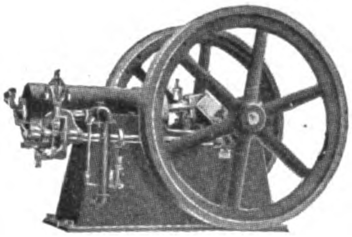
Motors, Engines, Boilers and Pumps
Mine & Contractors Machinery, New or Used



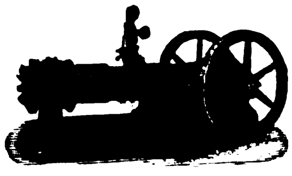
Derricks for every purpose—Building shows our location.

Products

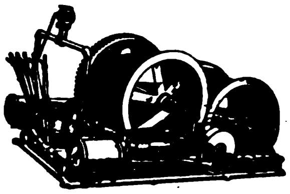
- Derricks and Fittings
- Drills for repair shops and rock
- Engines—Steam and Gas
- Fans—Mine and Blacksmith
- Boilers
- Crushers
- Machine Tools
- Smoke Stacks.
- Hammers—Steam, Power and Pile Driving
- Hoisting, Dump and Grab Buckets
- Shaft Sinking Machinery
- Pumps—Steam and Power
- Tanks—Pressure and Storage
- Hoists and Haulages—Steam, Electric and Gasoline



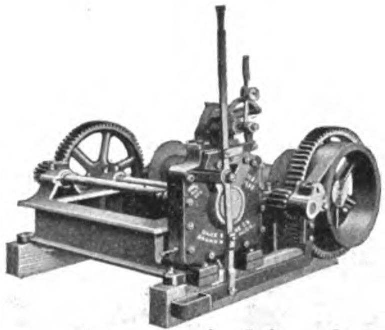
Gas and Gasoline Engines for Shops, Fans, Pumps and Power purposes.



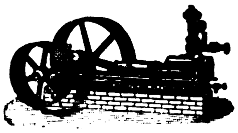
Air Compressors—Steam and Power.



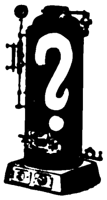
Our Specialty—Hoisting and Haulage Engines. Steam, Electric and Gasoline. For all mine operations; for derricks, handling building and mine supplies, etc.



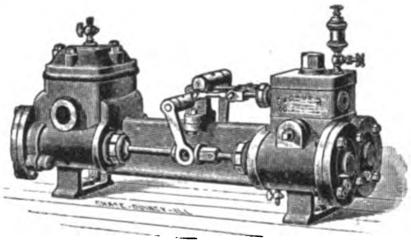
We show a steam or air driven hoist having a type of motor suitable for many uses; driving coal cutters at a very slow speed (by gears) for operations formerly done by hand.



Steam Engines for all purposes. Horizontal and Vertical Generating Units, direct or belted.



Boilers—Vertical Portable and Horizontal Tubular, to meet the various state requirements.



Steam and Power Pumps for Fire, Mine, Boiler Feed and Tank purposes, Single, Triplex and Centrifugal.

We usually have on hand a selection of drums from which we can build up electric hoists for moving cars at tipples, handling mine supplies, use in mines for pulling cars on dips, etc.

DUQUESNE ELECTRIC & MFG. CO.

Home Office
Bessemer Bldg.,
PITTSBURGH, PA.
Court 1112-1113

Factory and Warehouse
Binler St. and P. R. R.,
Opposite East Liberty Station,
Private Siding,

PITTSBURGH, PA.
Bell Phone, Hiland 6680

Branch Office
Marshall Bldg.,
CLEVELAND, OHIO
Central 2584-R

New and used power equipment.
Bought, sold, exchanged & Repaired.

Power Equipment

Immediate shipment of motors, generators, motor generator sets, gas engines, generator sets, mining machines, electric locomotives.

San Antonio Shipment.
One 500 Kw. 550 V.D.C. Generator to San Antonio Gas & Electric Co.

Switchboards, automatic controllers, hand starters. Motor driven mine fans and full line of accessories such as belting, pulleys, hangers; shafting of all sizes.

Pumps.

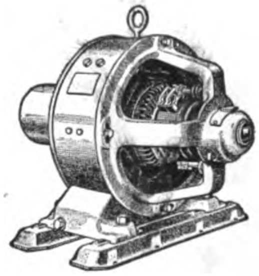
Full and complete line of A. C. and D. C. direct connected and geared pumps, all sizes, for immediate delivery.

Repair Work

Reasons Why You Should Send Us Your Repair Work:

1. We give prompt and efficient service.
2. We are especially equipped to handle all sizes and makes of Electrical Equipment.
3. We have our own Engineering Department and our experience in Designing and Rebuilding our own apparatus makes us expert in this line.
4. We have our own Coil Winding Department and carry a large stock of wire on hand.
5. We have one of the best and most modernly equipped shops in the country.
6. All apparatus before being shipped is given the same test as new equipment.
7. Dealing with us means thorough satisfaction.

GIVE US A TRIAL.



Engineering and Installing

Our Engineers have had years of experience in coal mining work and are capable of making appraisals, estimate reports, plans, specifications and installations.

Our Guarantee

We ship on 30 days approval and guarantee all machinery free from all Electrical and Mechanical defects.

ONE OF THE LARGEST STOCKS OF POWER MACHINERY IN THE UNITED STATES.

FRONT CONSTRUCTION COMPANY

1003-1004 House Buildiug
PITTSBURGH, PA.

Two Thoroughly Organized Divisions of Service

They Are Yours to Use. Prompt and Courteous Attention Given to All Inquiries

Our Service Saves TIME It's Precious Stuff, Wire Us In Cases of Emergency

WE BUY--SELL--EXCHANGE

USED EQUIPMENT DIVISION

Our Stock Includes

Air Compressors, from 50 to 2,000 cu. ft.

Boilers, Locomotive Type, Stationary.

Mine Cars, All Steel, Composite.

Tanks, Storage and Pressure.

Relaying Rail.

Motors and Motor Generator Sets.

Steam Generator Sets.

Complete structural steel buildings, re-erected at any location, or furnished complete F. O. B. Cars. Plans and specifications on request.

Our Guarantee

Covers every article that we sell. You are invited to inspect our stock at any time. If an inspection cannot be arranged you are perfectly safe in placing your order for your requirements. All equipment will come to you exactly as represented, and equal to new.

Our Prices

Are the lowest at all times.

Shipments

Can be made same day that order is received.

We buy Scrap Iron—Steel and Metals. Let us quote you on what you have. It's worth money; the receipts will offset your maintenance costs.

CONSTRUCTION DIVISION

Miner's Houses Built

By the up-to-date factory made system. Entire towns planned.

We can save you Time, Money, Trouble, because we:—

Absolutely gaurantee the quality of our materials.

Represent years of manufacture of wooden buildings.

Have product planned by experts.

Guarantee that your contracts will be satisfactoritly filled by us.

Are experienced in erection of all kinds of buildings, and handle the entire work, if you desire, with our own expert mechanics.

Have the facilities to save you time in the erection of complete camps or groups of buildings, and to design special types of buildings.

Save you money as our product is direct from mills manufacturing your requirements, complete from their own forests to you, eliminating unnecessary profits.

Prices, plans and details of construction furnished on application.

Your Inquiries Will Receive Personal Attention From the Firm.

Used Equipment Division,
H. B. PAYNE

Construction Division,
F. W. MEYSENBURG

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PITTSBURGH, PENNA

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Shop and Warerooms
233-217-219 First Avenue

Phones
Bell 1713-2697 Court. P. & A. 2251 Pitt

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GUARANTEED
REBUILT - USED - AND - NEW
ELECTRIC - MOTOR - AND
POWER - PLANT - APPARATUS

ESTABLISHED SINCE 1906—TWELVE YEARS OF SERVICE TO AN ALWAYS INCREASING CLIENTILE OF SATISFIED PATRONS

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We Buy Sell and Exchange Motors, Generators, Switchboards, Electric Hoists, Motor-Generator Sets, Rotary Convertors, Steam Electric Units, Rheostats, Gas Electric Units, Electric Pumps, Electric Mine Equipment, Motor Accessories, a large variety always in stock and available for prompt shipment.

Our Facilities

Warerooms with a total of 30,000 sq. ft. of floor space used to store equipment which has been overhauled and tested and is ready for prompt delivery. A shop equipment used exclusively for rebuilding our used apparatus. A force of expert mechanics and electricians supervised by a thoroughly practical and technical engineer. Complete facilities for making thorough operating tests. **"An organization devoted to the rebuilding of modern used equipment."**

Our Policy and Guarantee

We guarantee all equipment purchased from us to be free from electrical and mechanical defects and in strictly first-class operating condition. We will accept the return of equipment sold by us and proving unsatisfactory and allow credit in full or refund purchase price if returned within 30 days after date of sale.

We handle exclusively modern equipment of established reputation.

Our prices will effect you a saving of from 50% to 25% over the cost of similar new equipment.

REFERENCE—"ASK ANY OF YOUR NEIGHBORS"

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Office and Warehouse: 216-218 Penn Avenue

PITTSBURGH, PA.

Machinery—Power Plant Equipment

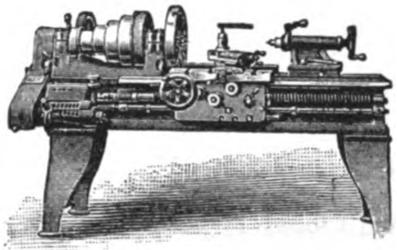
NEW AND USED

For

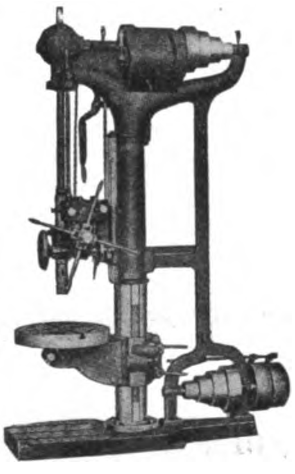
MILLS, MINES AND CONTRACTORS

Products

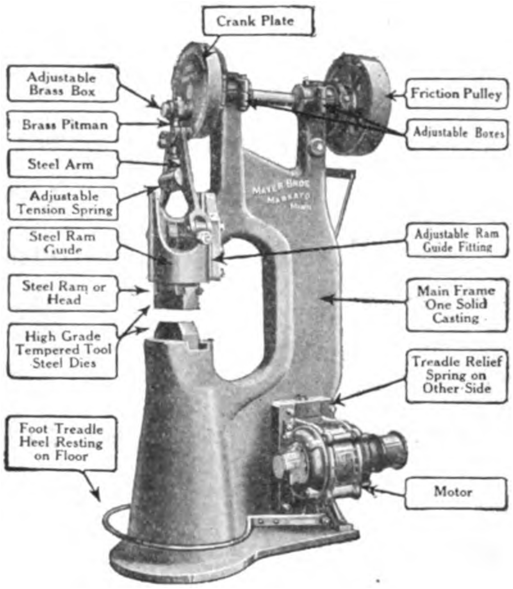
- Air Compressors
- Belting



- Bending Rolls
- Boring Mills
- Boilers
- Bolt Machinery
- Bulldozers
- Contractors' Equipment
- Corliss Engines
- Cranes, Electric Traveling
- Cranes, Locomotive
- Crushers
- Drill Presses
- Forge Shop Equipment
- Foundry Equipment
- Gas Engines
- Generators
- Grinders
- Hammers, all types



- Hoists, Electric, Steam
- Hydraulic Equipment
- Haulage and Hoisting Machinery
- Lathes
- Locomotives, Electric, Gas, Steam
- Locomotive Cranes

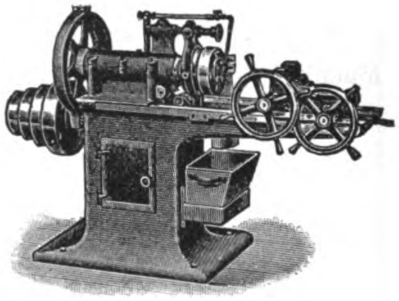

Crank Plate
Adjustable Brass Box
Brass Pitman
Steel Arm
Adjustable Tension Spring
Steel Ram Guide
Steel Ram or Head
High Grade Tempered Tool Steel Dies
Foot Treadle Heel Resting on Floor
Friction Pulley
Adjustable Boxes
Adjustable Ram Guide Fitting
Main Frame One Solid Casting
Treadle Relief Spring on Other Side
Motor

- "Little Giant" Hammers
- Milling Machines
- Mining Machinery and Equipment
- Mine Locomotives, Electric, Gasolene

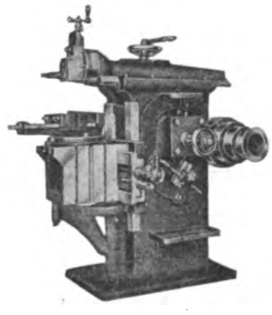
We are
MANUFACTURERS'
AGENTS
For
MACHINE TOOLS
of
EVERY DESCRIPTION.
We Solicit
YOUR
Inquiries.

WE BUY—SELL—EXCHANGE.

- Mine Locomotives, Storage Battery



- Motors
- Motor Starters (Allen-Bradley)
- Nut Machinery
- Pipe Machines
- Planers—(Metal, Wood)
- Presses—all types
- Pulleys—Big Stock
- Pumps
- Punches and Shears
- Rolls—Bending, Straightening
- Radial Drills
- Saws—Hot, Cold
- Screw Machines
- Shapers
- Shears and Punches
- Steam Engines
- Steam Shovels
- Testing Machines
- Turret Lathes



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943-953 North Front St.
PHILADELPHIA, PA.

General Machinery

Immediate Deliveries Rebuilt and Guaranteed
Modern and High Grade Machinery of Every Description

We carry in stock at Philadelphia a Complete Stock of the following types of New and Rebuilt Machinery:

BOILERS

Water Tube.

Horizontal.

Vertical and

Locomotive.

All Sizes.

PUMPS

Duplex and Single.

High and Low Pressure.

Steam and Belt.

AIR COMPRESSORS

Belt and Steam Driven.

ENGINES

Corliss.

Automatic and

Slide Valve.

HOISTING ENGINES

HEATERS

Open and Closed Type.

MACHINE TOOLS

Lathes.

Planers.

Shapers.

Milling Machines.

Drill Presses.

Radial Drills.

Etc., Etc.

Pulleys.

Shafting.

Hangers.

Belting and

General Mine Supplies.

FOR EVERY DUTY

I personally supervise the overhauling of all Machinery, and when the same leaves our place it is guaranteed first class in every respect.

SEND FOR COMPLETE CATALOGUE OF STOCK. CORRESPONDENCE SOLICITED

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

SHOP SECTION

Engineering Data

- Weight of Flat Iron.
- U. S. Standard Screw Threads.
- Weight of Square and Round Bars of Wrought Iron in Pounds of Lineal Foot.
- Average Weights of 100 Machine Bolts with Square Heads and Nuts.
- Table of Rivets in 100 Pounds.
- Weight of Common Carriage Bolts with Square Nut.
- Contents of Full Cases of Carriage Bolts.
- Diagram Showing Actual Sizes of U. S. Gage Wire and Sheet Metal.
- Contents of Full Kegs of Machine Bolts.
- Melting Points of Metals, in Fahrenheit.
- Strength of Wrought Iron Bolts.
- Length and Number of Cut Nails to the Pound.

The following manufacturers of shop equipment have catalogue descriptions in this section:

- Beaudry & Co., Inc.
- Borden Company, The.
- Buffalo Foundry & Machine Co.
- Davis-Bournonville Co.
- Imperial Brass Mfg. Co.
- Mayer Bros. Co.
- Milburn, Alexander & Co., The.
- Prest-O-Lite Co., Inc., The.
- Somers, Fitler & Todd Co.
- Toledo Pipe Threading Machine Co.

For additional descriptions of Shop Equipment not appearing in this section, refer to Index of Products in front of book.

Per lineal foot
in pounds

WEIGHT OF FLAT IRON

For steel about 2 per cent. should be added to the weight

Width in Inches	THICKNESS IN INCHES											
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/3	1
1	.21	.42	.63	.84	1.05	1.26	1.47	1.68	2.11	2.53	....	....
1 1/8	.24	.47	.71	.95	1.18	1.42	1.66	1.90	2.37	2.84	....	....
1 1/4	.26	.53	.79	1.05	1.32	1.58	1.84	2.11	2.63	3.16	3.68	4.21
1 3/8	.29	.58	.87	1.16	1.45	1.74	2.03	2.32	2.89	3.47	4.05	4.63
1 1/2	.32	.63	.95	1.26	1.58	1.90	2.21	2.53	3.16	3.79	4.42	5.05
1 5/8	.34	.68	1.03	1.37	1.71	2.05	2.39	2.74	3.42	4.11	4.79	5.47
1 3/4	.37	.74	1.11	1.47	1.84	2.21	2.58	2.95	3.68	4.42	5.16	5.89
2	.42	.84	1.26	1.68	2.11	2.53	2.95	3.37	4.21	5.05	5.89	6.74
2 1/4	.47	.95	1.42	1.90	2.37	2.84	3.32	3.79	4.74	5.68	6.83	7.58
2 1/2	.53	1.05	1.58	2.11	2.63	3.16	3.68	4.21	5.26	6.32	7.37	8.42
2 3/4	.58	1.16	1.74	2.32	2.89	3.47	4.05	4.63	5.79	6.95	8.10	9.26
3	.63	1.26	1.90	2.53	3.16	3.79	4.42	5.05	6.32	7.58	8.84	10.10
3 1/4	.68	1.37	2.05	2.74	3.42	4.11	4.79	5.47	6.84	8.21	9.58	10.95
3 1/2	.74	1.47	2.21	2.95	3.68	4.42	5.16	5.89	7.37	8.84	10.32	11.79
3 3/4	.79	1.58	2.37	3.16	3.95	4.74	5.53	6.32	7.89	9.47	11.05	12.63
4	.84	1.68	2.53	3.37	4.21	5.05	5.89	6.74	8.42	10.10	11.79	13.47
4 1/2	.95	1.90	2.84	3.79	4.74	5.68	6.63	7.58	9.47	11.38	13.26	15.16
5	1.05	2.11	3.16	4.21	5.26	6.32	7.37	8.42	10.53	12.63	14.74	16.84
5 1/2	1.16	2.32	3.47	4.63	5.79	6.95	8.10	9.26	11.58	13.89	16.21	18.52
6	1.26	2.53	3.79	5.05	6.32	7.58	8.84	10.10	12.63	15.16	17.68	20.21
7	1.47	2.94	4.42	5.90	7.36	8.84	10.32	11.79	14.74	17.68	20.64	23.58
8	1.68	3.36	5.05	6.74	8.42	10.10	11.78	13.48	16.84	20.20	23.58	26.94

U. S. STANDARD SCREW THREADS

Diameter	Threads per Inch	Diameter of Root of Thread	Width of Flat	Area of Bolt Body	Area at Root of Thread	Short Diameter of Nut, Rough	Short Diameter of Nut, Finished	Long Diameter of Hex. Nut, Rough	Long Diameter of Square Nut, Rough	Thickness of Nut, Rough	Thickness of Nut, Finish
Ins.		Ins.	Ins.	Sq. Ins.	Sq. Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
1/4	20	.185	.0062	.049	.027	1/2	7/16	37/64	7/10	1/4	3/16
5/16	18	.240	.0074	.077	.045	19/32	17/32	11/16	10/12	5/16	1/4
3/8	16	.294	.0078	.110	.068	11/16	5/8	51/64	63/64	3/8	5/16
7/16	14	.344	.0089	.150	.093	25/32	23/32	9/10	1 7/64	7/16	3/8
1/2	13	.400	.0096	.196	.126	7/8	13/16	1	1 15/64	1/2	7/16
9/16	12	.454	.0104	.249	.162	31/32	29/32	1 1/8	1 23/64	9/16	1/2
5/8	11	.507	.0113	.307	.202	1 1/16	1	1 7/32	1 1/2	5/8	9/16
3/4	10	.620	.0125	.442	.302	1 1/4	1 3/16	1 7/16	1 49/64	3/4	11/16
7/8	9	.731	.0138	.601	.420	1 7/16	1 3/8	1 21/32	2 1/32	7/8	13/16
1	8	.837	.0156	.785	.550	1 5/8	1 9/16	1 7/8	2 19/64	1	15/16
1 1/8	7	.940	.0178	.994	.694	1 13/16	1 3/4	2 3/32	2 9/16	1 1/8	1 1/16
1 1/4	7	1.065	.0178	1.227	.893	2	1 15/16	2 5/16	2 53/64	1 1/4	1 3/16
1 3/8	6	1.160	.0208	1.485	1.057	2 3/16	2 1/8	2 17/32	3 3/32	1 3/8	1 5/16
1 1/2	6	1.284	.0208	1.767	1.295	2 3/8	2 5/16	2 3/4	3 23/64	1 1/2	1 7/16
1 5/8	5 1/2	1.389	.0227	2.074	1.515	2 9/16	2 1/2	2 31/32	3 5/8	1 5/8	1 9/16
1 3/4	5	1.491	.0250	2.405	1:746	2 3/4	2 11/16	3 3/16	3 57/64	1 3/4	1 11/16
1 7/8	5	1.616	.0250	2.761	2.051	2 15/16	2 7/8	3 13/32	4 5/32	1 7/8	1 13/16
2	4 1/2	1.712	.0277	3.142	2.302	3 1/8	3 1/16	3 5/8	4 27/64	2	1 15/16
2 1/4	4 1/2	1.962	.0277	3.976	3.023	3 1/2	3 7/16	4 1/16	4 61/64	2 1/4	2 3/16
2 1/2	4	2.176	.0312	4.909	3.719	3 7/8	3 13/16	4 1/2	5 31/64	2 1/2	2 7/16
2 3/4	4	2.426	.0312	5.940	4.620	4 1/4	4 3/16	4 29/32	6	2 3/4	2 11/16
3	3 1/2	2.629	.0357	7.069	5.428	4 5/8	4 9/16	5 3/8	6 17/32	3	2 15/16
3 1/4	3 1/2	2.879	.0357	8.296	6.510	5	4 15/16	5 13/16	7 1/16	3 1/4	3 3/16
3 1/2	3 1/4	3.100	.0384	9.621	7.548	5 3/8	5 5/16	6 7/64	7 39/64	3 1/2	3 7/16
3 3/4	3	3.317	.0413	11.045	8.641	5 3/4	5 11/16	6 21/32	8 1/8	3 3/4	3 11/16
4	3	3.567	.0413	12.566	9.963	6 1/8	6 1/16	7 3/32	8 41/64	4	3 15/16
4 1/4	2 7/8	3.798	.0435	14.186	11.329	6 1/2	6 7/16	7 9/16	9 3/16	4 1/4	4 3/16
4 1/2	2 3/4	4.028	.0454	15.904	12.753	6 7/8	6 13/16	7 31/32	9 3/4	4 1/2	4 7/16
4 3/4	2 5/8	4.256	.0476	17.721	14.226	7 1/4	7 3/16	8 13/32	10 1/4	4 3/4	4 11/16
5	2 1/2	4.480	.0500	19.635	15.763	7 5/8	7 9/16	8 27/32	10 49/64	5	4 15/16
5 1/4	2 1/2	4.730	.0500	21.648	17.572	8	7 15/16	9 9/32	11 23/64	5 1/4	5 3/16
5 1/2	2 3/8	4.953	.0526	23.758	19.267	8 3/8	8 5/16	9 23/32	11 7/8	5 1/2	5 7/16
5 3/4	2 3/8	5.203	.0526	25.967	21.262	8 3/4	8 11/16	10 5/32	12 3/8	5 3/4	5 11/16
6	2 1/4	5.423	.0555	28.274	23.098	9 1/8	9 1/16	10 19/32	12 15/16	6	5 15/16

Weights of Square and Round Bars of Wrought Iron

In Pounds Per Lineal Foot.—*Kent.*
Iron weighing 480 lbs. per cubic foot. For steel add 2 per cent.

Thickness or Diameter in Inches	Weight of Square Bar One Foot Long	Weight of Round Bar One Foot Long	Thickness or Diameter in Inches	Weight of Square Bar One Foot Long	Weight of Round Bar One Foot Long
0					
1-16	.013	.010	3 1-16	31.26	24.55
1-8	.052	.041	1-8	32.55	25.57
3-16	.117	.092	3-16	33.87	26.60
1-4	.208	.164	1-4	35.21	27.65
5-16	.326	.256	5-16	36.58	28.73
3-8	.469	.368	3-8	37.97	29.82
7-16	.638	.501	7-16	39.39	30.94
1-2	.833	.654	1-2	40.83	32.07
9-16	1.055	.828	9-16	42.30	33.23
5-8	1.302	1.023	5-8	43.80	34.40
11-16	1.576	1.237	11-16	45.33	35.60
3-4	1.875	1.473	3-4	46.88	36.82
13-16	2.201	1.728	13-16	48.45	38.05
7-8	2.552	2.004	7-8	50.05	39.31
15-16	2.930	2.301	15-16	51.68	40.59
1	3.333	2.618	4	53.33	41.89
1-16	3.763	2.955	1-16	55.01	43.21
1-8	4.219	3.313	1-8	56.72	44.55
3-16	4.701	3.692	3-16	58.45	45.91
1-4	5.208	4.091	1-4	60.21	47.29
5-16	5.742	4.510	5-16	61.99	48.69
3-8	6.302	4.950	3-8	63.80	50.11
7-16	6.888	5.410	7-16	65.64	51.55
1-2	7.500	5.890	1-2	67.50	53.01
9-16	8.138	6.392	9-16	69.39	54.50
5-8	8.802	6.913	5-8	71.30	56.00
11-16	9.492	7.455	11-16	73.24	57.52
3-4	10.21	8.018	3-4	75.21	59.07
13-16	10.95	8.601	13-16	77.20	60.63
7-8	11.72	8.204	7-8	79.22	62.22
15-16	12.51	9.828	15-16	81.26	63.82
2	13.33	10.47	5	83.33	65.45
1-16	14.18	11.14	1-16	85.43	67.10
1-8	15.05	11.82	1-8	87.55	68.76
3-16	15.95	12.53	3-16	89.70	70.45
1-4	16.88	13.25	1-4	91.88	72.16
5-16	17.83	14.00	5-16	94.08	73.89
3-8	18.80	14.77	3-8	96.30	75.64
7-16	19.80	15.55	7-16	98.55	77.40
1-2	20.83	16.36	1-2	100.8	79.10
9-16	21.89	17.19	9-16	103.1	81.00
5-8	22.97	18.04	5-8	105.5	82.83
11-16	24.08	18.91	11-16	107.8	84.69
3-4	25.21	19.80	3-4	110.2	86.56
13-16	26.37	20.71	13-16	112.6	88.45
7-8	27.55	21.64	7-8	115.1	90.36
15-16	28.76	22.59	15-16	117.5	92.29
3	30.00	23.56	6	120.0	94.25

AVERAGE WEIGHT PER 100 MACHINE BOLTS WITH SQUARE HEADS AND NUTS

Length	¼	5/16	⅜	7/16	½	9/16	⅝	¾	⅞	1	1⅛	1¼
1½	3.7	6.0	9.0	15.2	19.6	27.5	34.3	54.3	....	....	....	....
2	4.2	7.0	10.5	17.2	22.2	31.0	38.4	60.0	90.8	....	....	....
2½	4.8	8.0	12.0	19.2	24.8	34.5	42.5	65.7	99.1	148.2	209.0	277.0
3	5.5	9.0	13.5	21.2	27.5	38.0	46.7	71.4	107.4	159.0	222.5	293.5
3½	6.1	10.0	15.0	23.2	30.1	41.5	50.8	77.1	115.7	169.8	236.6	310.0
4	6.8	11.0	16.5	25.2	32.8	45.0	55.0	82.8	124.0	180.6	249.5	326.5
4½	7.4	12.0	18.0	27.2	35.4	48.5	59.1	88.9	132.3	191.4	263.0	343.0
5	8.1	13.0	19.5	29.2	38.1	52.0	63.3	95.0	140.6	202.2	276.5	359.5
5½	8.7	14.0	21.0	31.2	40.7	55.5	67.4	101.1	148.9	213.0	290.0	376.0
6	9.4	15.0	22.5	33.2	43.4	59.0	71.6	107.2	157.2	223.8	303.5	392.5
6½	10.1	16.0	24.1	35.2	46.0	62.5	75.7	113.3	165.5	234.6	317.0	409.0
7	10.8	17.0	25.7	37.2	48.7	66.0	79.9	119.4	173.8	245.4	330.5	425.5
7½	11.5	18.0	27.3	39.2	51.3	69.5	84.0	125.5	182.1	256.2	344.0	442.0
8	12.2	19.0	28.9	41.2	54.0	73.0	88.2	131.6	190.4	267.0	357.5	458.5
9	....	....	32.1	45.2	59.5	80.0	96.5	143.8	207.0	288.6	385.5	493.0
10	....	....	35.3	49.2	65.0	87.0	104.8	156.0	223.6	310.2	413.5	527.5
11	....	....	38.5	53.2	70.5	94.0	113.1	168.2	240.2	331.8	441.5	562.0
12	....	....	41.7	57.2	76.0	101.0	121.4	180.4	256.8	353.4	469.5	596.5
13	....	....	....	....	81.5	108.0	129.7	192.6	273.4	375.0	497.5	631.0
14	....	....	....	....	87.0	115.0	138.0	204.8	290.0	396.6	525.5	665.5
15		....	....	....	92.5	122.0	146.3	217.0	306.6	418.2	553.5	700.0
16	....	....	....	....	98.0	129.0	154.6	229.2	323.2	439.8	581.5	734.5
17	....	....	....	....	103.5	136.0	162.9	241.4	339.8	461.4	609.5	769.0
18	....	....	....	....	109.0	143.0	171.2	253.6	356.4	483.0	637.5	803.5
19	....	....	....	....	114.5	150.0	179.5	265.8	373.0	504.6	665.5	838.0
20	....	....	....	....	120.0	157.0	187.8	278.0	389.6	526.2	693.5	872.5
21	....	....	....	....	125.5	164.0	196.1	290.4	406.5	548.2	721.5	907.0
22	....	....	....	....	131.0	171.0	204.4	302.8	423.4	570.2	749.5	941.5
23	....	....	....	....	136.5	178.0	212.7	315.2	440.3	592.2	777.5	976.0
24	....	....	....	....	142.0	185.0	221.0	327.6	457.2	614.2	805.5	1010.5
25	....	....	....	....	147.5	192.0	229.3	340.0	474.1	636.2	833.5	1045.0
26	....	....	....	....	153.0	199.0	237.6	352.4	491.0	658.2	861.5	1079.5
27	....	....	....	....	158.5	206.0	245.9	364.8	507.9	680.2	889.5	1114.0
28	....	....	....	....	164.0	213.0	254.2	377.2	524.8	702.2	917.5	1148.5
29	....	....	....	....	169.5	220.0	262.5	389.6	541.7	724.2	945.5	1183.0
30	....	....	....	....	175.0	227.0	270.8	402.0	558.6	746.2	973.5	1217.5

TABLE OF RIVETS IN 100 POUNDS

Approximate Number.

Length Rivets	Diameter of Rivets.											
	1-8	3-16	1-4	5-16	3-8	7-16	1-2	5-8	11-16	3-4	7-8	1
½	17500	15900	8000	5100	3200	1900	....	....	....	....	....	....
⅝	16000	13800	7000	4500	2900	1800	....	....	....	....	....	....
¾	14400	12200	6300	4100	2373	1476	1103	642	....	....	....	....
⅞	13500	10900	5700	3700	2190	1371	1030	604	....	....	....	....
1	12600	9800	5200	3400	2034	1280	968	571	400	345	....	....
1⅛	11600	9000	4700	3100	1898	1200	910	541	382	322	208	....
1¼	10800	8300	4400	2900	1780	1129	862	514	365	311	206	....
1⅜	10000	7600	4100	2700	1675	1066	815	489	350	295	204	....
1½	9300	7100	4000	2500	1582	1010	776	462	335	284	201	....
1⅝	8700	...	3800	2300	1498	960	740	446	324	275	199	132
1¾	8100	6300	3500	2200	1424	914	707	428	311	266	192	128
1⅞	....	....	3400	2000	1356	872	672	411	302	257	185	124
2	....	5600	3000	1900	1295	834	648	395	293	249	178	120
2⅛	....	....	....	....	1238	800	623	381	285	240	172	116
2¼	....	5000	2800	1800	1187	768	599	367	277	233	167	112
2⅜	....	....	....	....	1139	738	577	354	269	226	162	108
2½	....	4600	2500	1700	1095	711	556	343	261	219	157	104
2⅝	....	....	....	....	1052	687	537	332	253	212	152	100
2¾	....	4200	2300	1500	1017	662	519	321	245	206	148	96
2⅞	....	....	....	....	982	636	503	311	237	201	144	92
3	....	3900	2200	1400	949	611	487	302	230	196	140	88
3¼	....	3600	2000	1300	890	581	459	285	218	186	132	85
3½	....	3400	1900	1200	837	548	433	270	208	177	126	82
3¾	....	3200	1800	1175	791	519	411	257	198	168	120	79
3⅞	....	....	....	....	....	....	395	250	195	165	119	....
4	....	3000	1700	1100	749	400	390	244	189	161	115	77
4¼	....	....	1600	1050	700	....	372	233	180	155	110	75
4½	....	....	1500	1000	650	....	355	223	172	149	105	73
4¾	....	....	1475	925	625	....	339	214	166	143	101	71
5	....	....	1400	900	600	....	325	205	160	136	97	69
5¼	....	....	1350	850	575	....	312	197	154	131	94	67
5½	....	....	1300	825	550	....	300	190	149	127	91	65
5¾	....	....	1250	775	525	....	289	183	144	123	88	63

WEIGHT OF COMMON CARRIAGE BOLTS WITH SQUARE NUTS

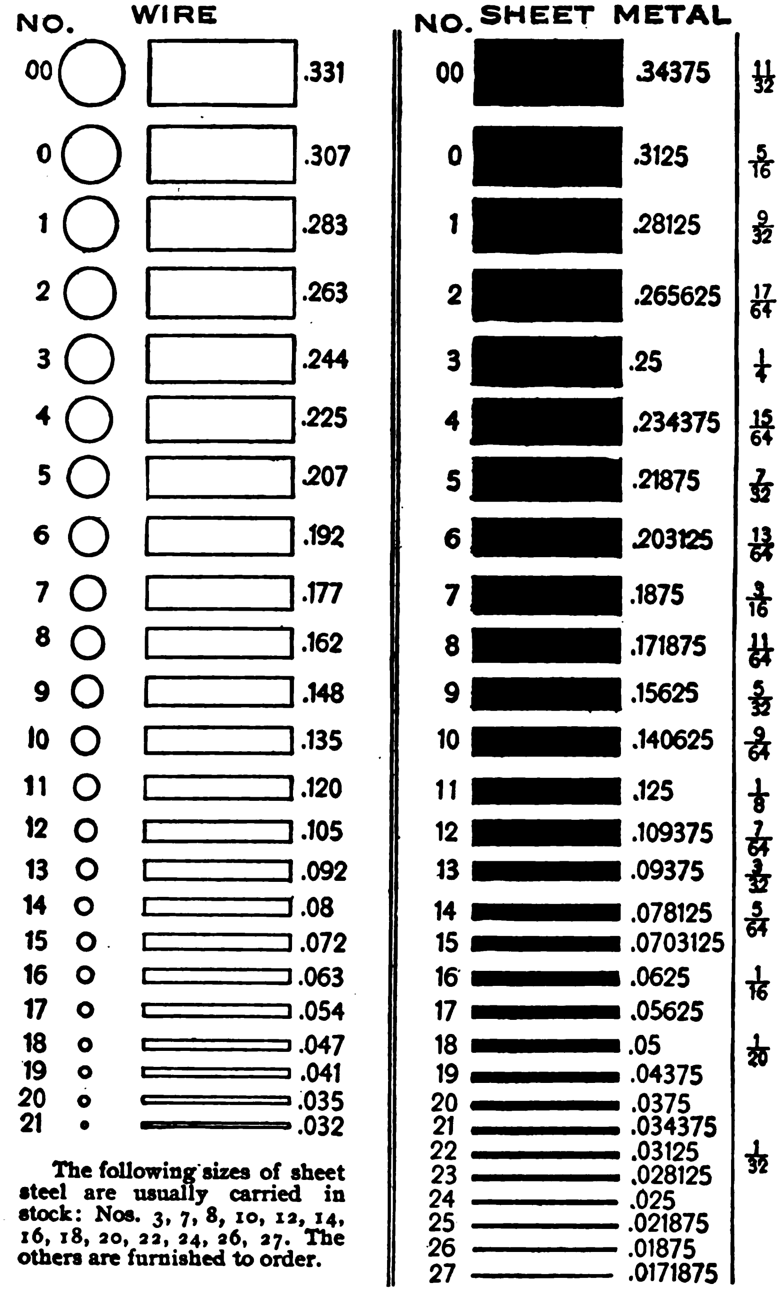
Table showing the average weight in pounds of 100 Common Carriage Bolts of sizes enumerated.

Diameter	¼	5/16	⅜	7/16	½	⅝	¾
Length in Inches	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1	2.6	4.6	7.1	10.8	14.5	27.1	
1½	3.2	5.6	8.5	12.8	17.1	31.2	
2	3.9	6.5	10.0	14.7	19.6	35.3	
2½	4.5	7.5	11.4	16.7	22.2	39.4	58.4
3	5.2	8.4	12.9	18.6	24.7	43.5	64.4
3½	5.8	9.4	14.3	20.6	27.3	47.6	70.3
4	6.5	10.3	15.8	22.5	29.8	51.7	76.3
4½	7.1	11.3	17.2	24.5	32.4	55.8	82.2
5	7.8	12.2	18.7	26.4	34.9	59.9	88.2
5½	8.4	13.2	20.1	28.4	37.5	64.0	94.1
6	9.1	14.1	21.6	30.3	40.0	68.1	100.1
6½	9.7	15.1	23.0	32.3	42.6	72.2	106.0
7	10.4	16.0	24.5	34.2	45.1	76.3	112.0
7½	11.0	17.0	25.9	36.2	47.7	80.4	117.9
8	11.7	17.9	27.4	38.1	50.2	84.5	123.9
8½	12.3	18.9	28.8	40.1	52.8	88.6	129.8
9	13.0	19.8	30.3	42.0	55.3	92.7	135.8
9½	13.6	20.8	31.7	44.0	57.9	96.8	141.7
10	14.3	21.7	33.2	45.9	60.4	100.9	147.7
10½	14.9	22.7	34.6	47.9	63.0	105.0	153.6
11	15.6	23.6	36.1	49.8	65.5	109.1	159.6
11½	16.2	24.6	37.5	51.8	68.1	113.2	165.5
12	16.9	25.5	39.0	53.7	70.6	117.3	171.5

CONTENTS
FULL CASES OF CARRIAGE BOLTS
APPROXIMATELY

Length Inches	Diam. ¼"	Diam. 5/16"	Diam. ⅜"	Diam. 7/16"	Diam. ½"	Diam. ⅝"
1	6000	5000	5000	2700	2000	
1¼	6400	4800	4200	2600	2000	
1½	5200	5000	3600	2400	1800	
1¾	4500	4600	3200	2100	1600	
2	4000	4200	3000	2000	1600	900
2¼	3600	3500	2700	1750	1600	900
2½	4200	4500	3000	1600	1600	900
2¾	3600	4000	2700	2000	1600	850
3	3900	4000	3100	2000	1600	850
3¼	3600	2200	2400	1600	1400	700
3½	3600	3800	2400	1400	1400	700
3¾	3600	2000	2400	1400	1200	600
4	4500	3500	2400	1400	1200	600
4¼	3400	1600	2200	1400	1200	600
4½	3400	3500	2200	1000	1200	700
4¾	3000	1800	2200	1000	1200	600
5	3000	3200	2400	1000	1000	650
5½	2800	2700	2000	600	1000	600
6	2400	2400	1800	550	900	450
6½		2400	1650	550	900	450
7		1800	1600	550	900	450
7½		1800	1450	550	850	450
8			1350	550	650	400
8½			1200	500	600	350
9			1100	500	600	350
9½			1050	500	550	300
10			850	500	550	300
10½					500	300
11					500	300
11½					500	250
12					400	250
12½					400	250
13					400	250
13½					400	200
14					400	200

DIAGRAM SHOWING ACTUAL SIZES OF U. S. GAGE



NO.	WIRE	NO.	SHEET METAL	
00	.331	00	.34375	11/32
0	.307	0	.3125	5/16
1	.283	1	.28125	9/32
2	.263	2	.265625	17/64
3	.244	3	.25	1/4
4	.225	4	.234375	15/64
5	.207	5	.21875	7/32
6	.192	6	.203125	13/64
7	.177	7	.1875	3/16
8	.162	8	.171875	11/64
9	.148	9	.15625	5/32
10	.135	10	.140625	9/64
11	.120	11	.125	1/8
12	.105	12	.109375	7/64
13	.092	13	.09375	3/32
14	.08	14	.078125	5/64
15	.072	15	.0703125	
16	.063	16	.0625	1/16
17	.054	17	.05625	
18	.047	18	.05	1/20
19	.041	19	.04375	
20	.035	20	.0375	
21	.032	21	.034375	
		22	.03125	1/32
		23	.028125	
		24	.025	
		25	.021875	
		26	.01875	
		27	.0171875	

The following sizes of sheet steel are usually carried in stock: Nos. 3, 7, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 27. The others are furnished to order.

CONTENTS FULL KEGS MACHINE BOLTS

Length Inches	Diam. 3/8"	Diam. 1/2"	Diam. 5/8"	Diam. 3/4"	Diam. 7/8"	Diam. 1"
1 inch . . .	3000	1300	750	500	250	....
1½	2600	1200	700	475	250	....
1¾	2500	1100	700	425	250	....
2 . . .	2400	1000	575	400	250	200
2¼	2200	950	550	375	200	175
2½	2000	900	525	350	200	175
2¾	1800	850	475	325	175	150
3	1700	800	450	300	175	125
3¼	1600	700	425	275	175	125
3½	1500	650	400	275	175	125
3¾	1400	625	375	250	175	100
4	1400	600	350	250	175	100
4¼	....	575	325	225	150	100
4½	1100	550	325	225	150	100
4¾	....	525	300	200	150	90
5	900	500	300	200	125	80
5½	....	450	275	200	125	75
6	....	425	275	175	100	75
6½ . . .	....	400	250	175	100	....
7	....	375	250	175	100	....
7½	....	350	225	150	....	....
8	....	350	225	150	....	....

Melting Points of Metals, in Fahrenheit

		Degrees.
Alloy, 3 Lead, 2 Tin, 5 Bismuth ...		200
Alloy, 1 Tin, 1 Lead		370-460
Aluminum		1,160
Aluminum Bronze		1,700
Antimony		950
Bismuth		510
Brass		1,870
Bronze		1,690
Copper		2,000
Gold		2,020
Iron, Cast	(white)	2,075
	(gray)	2,264
Iron, Wrought		3,000-3,500
Lead		610
Magnesium		1,200
Mercury		39
Platinum		3,500
Steel		2,370-2,550
Silver		1,860
Tin		445
Zinc		700

Strength of Wrought Iron Bolts

Diameter of Bolt in Inches.	Safe Load in Pounds.
½	1000
⅝	1800
¾	2750
⅞	3800
1	500
1⅛	62500
1¼	8050
1⅜	10000
1½	11800
1¾	15750
2	20800

CUT NAILS AND TACKS

Length and Number of Cut Nails to the Pound.

Size.	Length.	Common.	Clinch.	Fence.	Finishing.	Fine.	Barrel.	Casing.	Brads.	Tobacco.	Cut Spikes.
¾	¾ in.	...	...	...	....	....	940	....	...	...	....
⅞	⅞ in.	900	...	...	....	....	804	...	..	...	....
2d	1 in.	900	622	...	1558	1558	542	1140	...	...	....
3d	1¼ in.	615	412	...	884	884	322	675	...	...	....
4d	1½ in.	322	339	...	767	767	180	567	...	..	....
5d	1¾ in.	250	230	127	491	....	...	396	...	256	....
6d	2 in.	200	155	114	359	....	...	260	...	226	....
7d	2¼ in.	154	110	88	317	....	...	239	126	145	....
8d	2½ in.	106	98	74	214	....	..	160	98	130	....
9d	2¾ in.	85	86	58	195	....	...	148	75	100	....
10d	3 in.	74	66	42	134	....	...	108	65	85	....
12d	3¼ in.	57	57	36	120	....	...	99	55	65	28
16d	3½ in.	46	46	28	91	....	..	69	40	...	....
20d	4 in.	29	35	22	61	....	...	50	27	. .	22
30d	4½ in.	23	28	...	....	....	..	45	...	...	14½
40d	5 in.	17	...	...	....	....	..	35	...	...	12½
50d	5½ in.	13½	...	...	....	....	..	...	..	...	9½
60d	6 in.	10½	...	...	....	....	...	..	...	...	8
...	6½ in.	...	...	...	....	....	...	...	...	...	6
...	7 in.	...	...	...	....	....	...	...	...	...	5½
....	8 in.	...	...	...	....	....	....	...	...	...	4½
											2½

BEAUDRY & COMPANY, Inc.

141 Milk Street, Boston, Mass., U. S. A.

SALES AGENTS

Brown & Zortman Machinery Co., Pittsburgh, Pa.
Eccles & Smith Co., San Francisco, Los Angeles, Calif., Portland, Ore.
Hallidie Machinery Co., Inc., Seattle, Wash.
C. T. Patterson & Co., Ltd., New Orleans, La.
Sherritt & Stoer Co., Philadelphia, Pa.
The English Tool & Supply Co., Kansas City, Mo.
The E. L. Essley Machinery Co., Chicago, Ill., Milwaukee, Wis.
Alfred Herbert, Ltd., Coventry, Eng., London, Paris, Calcutta, Yokohama.

Manufacturers of

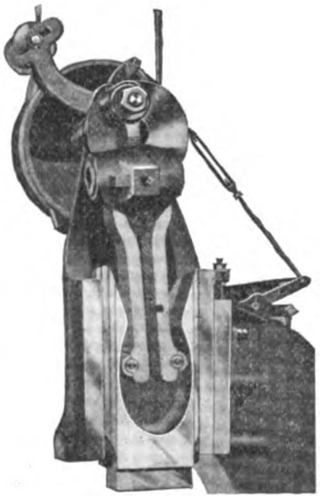
Beaudry Power Hammers

Products

Beaudry Champion Power Hammers.

Beaudry Hammers

Are designed for light and heavy railroad, machine, and general blacksmithing. The foremost advantage is the superior elasticity, perfect control and force of the blow struck by it. It has no beam, no saddle, no rubber cushions, leather straps, or coiled springs. Its ram or head is of steel and has an internal curved track of ( ) shape as shown in the section cut, and by the dotted outline on the large picture. Two steel spring arms, with hardened tool steel rollers at their lower extremeties, operate within the ram and on the curved track, and serve to lift and throw the ram.



The action of the spring arms controls the ram and causes it to rebound the instant the blow is struck, without reaction or jump, or without throwing sudden strain on any of the parts. The full stroke can be had on a piece four inches square as readily as on a piece one eighth of an inch thick without change of adjustment.

Control

The hammer is started, stopped, and regulated by a foot treadle extending around the base of the machine. Through a varying pressure on this can be obtained any speed or force of blow from one pound up to full blow, estimated to be six times the weight of the ram.

Anvil

The anvil clears the frame, as can be seen by the curved lines of the frame. It is an independent casting, and stands on its own foundation. The angular setting permits bars of any length to be worked either way of the dies.

Ram

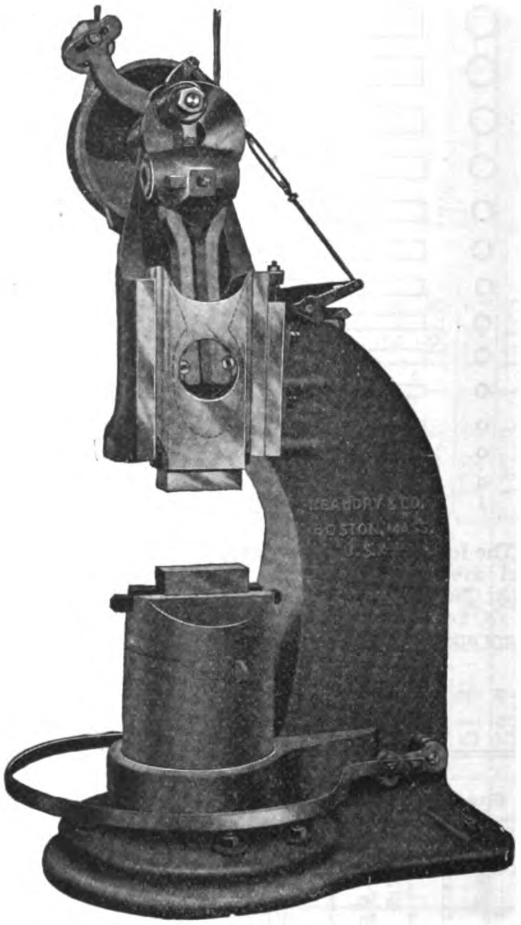
The Ram is of steel and is carefully machined and fitted into heavy trough-shaped guides. It is adjustable, on its connecting rod, to varying heights above the dies, and at the same time is well contained within the guides.

The Spring Arms

The Spring Arms are forged from Swedish steel and are carefully tempered. The rolls are of hardened tool steel.

Brake

The brake is absolutely positive, and will stop the machine and hold it in any position of the stroke. In the driving pulley is a counter weight to compensate for the weight of the ram. By it the hammer is balanced and stops up, ready for work.



The Beaudry Champion Power Hammer.

Motor Drive

Beaudry Hammers are readily arranged for motor drive, forming a neat and compact unit where it is not practicable to take power from a line shaft or where the blacksmith shop is isolated.

THE BEAUDRY CHAMPION POWER HAMMER
SIZES AND DIMENSIONS

No. of Hammer	2	3	4	5	6	7	8	9	11	12
Weight of Ram, lbs.	**50**	**75**	**100**	**125**	**150**	**200**	**250**	**300**	**400**	**500**
Estimated Force of Blows, lbs.	300	450	600	750	900	1200	1500	1800	2400	3000
Lift of Ram, inches	6	7	8	8½	9	10	11	11½	12½	13
Average Size Work, inches	1½	1¾	2¼	2½	3	3½	4	4½	5	6
Speed of Hammer	300	300	275	275	250	225	225	200	175	175
Diameter of Driving Pulley, inches	14	14	16	16	17	18	18	19	20	22
Face of Driving Pulley, inches	3	3	3½	3½	4	4	4½	5	6	7
Approx. Weight of Hammer, lbs.	2000	2400	3000	3200	3700	4400	4800	5400	7000	9000

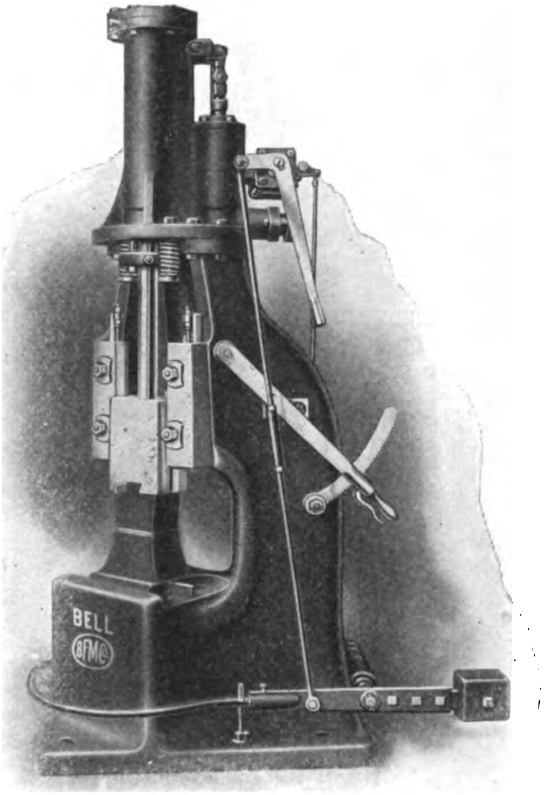
No. 2 is made with anvil base cast solid with frame; all other sizes have separate anvils
Bars of any length may be worked either way of dies.

Buffalo Foundry and Machine Co

13 Winchester Avenue BUFFALO. N. Y

New York Office, 17 Battery Place

"Bell Steam Hammers"

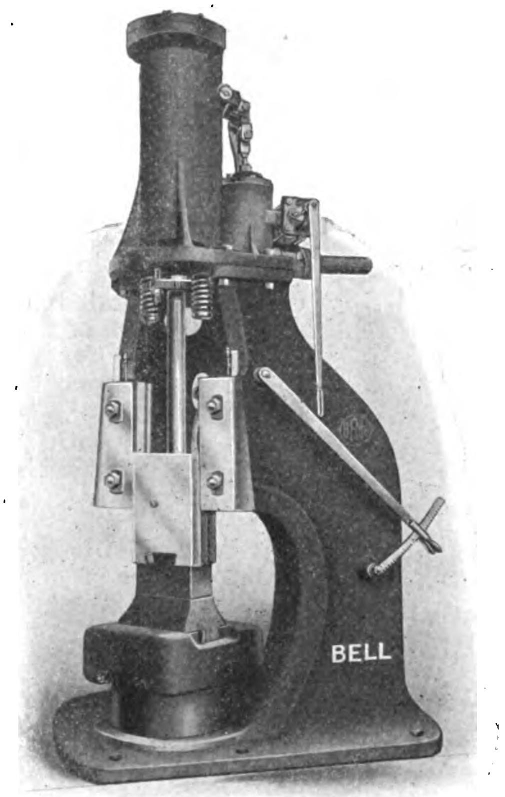


Steel Frame Combined Hammer

Combines the flexibility of the Standard guide type of steam hammer with the essential features of the steam drop hammer, and can be operated by the foot treadle the same as on a belt driven hammer. Suitable for the lighter cleasses of general blacksmith work, and will make forgings from round or square stock up to 6 or 8 inches.

These hammers are now handling the widest range of forge and shape work, and have the special "Bell" features of reinforced guides, stiffened column construction, automatic drainage of the water of condensation, removable cam plate, etc.

Built in sizes from 100 lbs. to 850 lbs.



Standard Guide Single Frame

Suitable for the heavier classes of mining, railroad and other blacksmith work. Will make forgings from round or square stock up to 6 or 8 inches. Provided with reinforced guide and stiffened column in order to withstand the severe strains caused by sometimes striking blows away from the center of the die.

The die or anvil block is as nearly unbreakable as it is possible to provide. The lower block, which extends through the cored hole in the bed plate, is so constructed that it is inconceivable that it can be broken. This type is built in sizes from 850 lbs. to 6000 lbs. (rated according to the scale weight of the falling part).

A "Bell" Hammer pays for itself through improved quality and increased quantity of work, where even a single blacksmith fire is operated.

Write for the "Bell" Catalog which gives full information regarding the above and other types of "Bell" Hammers.

MAYER BROTHERS COMPANY

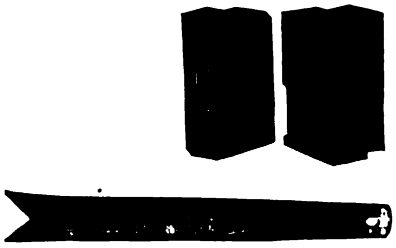
191 Rock St. Mankato Minn. U. S. A.

Little Giant Power Hammer

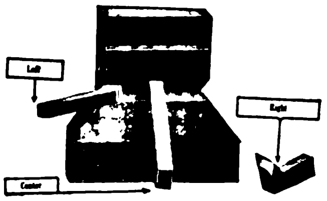
Belt or Individual Motor Driven

25, 50, 100, 250 and 500 lb. Models.

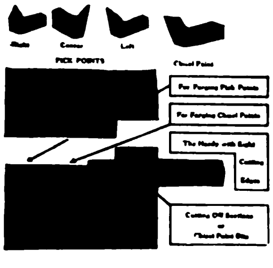
Good Tools Means More Coal at Less Cost.



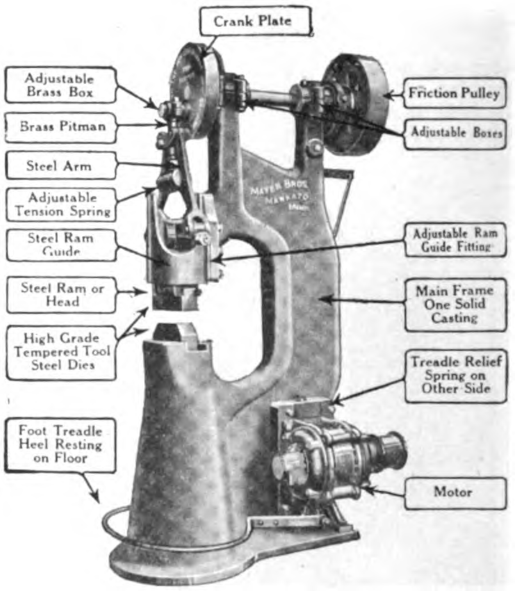
Little Giant Puncher Pick Dies.



Little Giant Pick Point Dies.



Little Giant Combination Pick Point and Chisel Bit Dies.


Crank Plate
Adjustable Brass Box
Brass Pitman
Steel Arm
Adjustable Tension Spring
Steel Ram Guide
Steel Ram or Head
High Grade Tempered Tool Steel Dies
Foot Treadle Heel Resting on Floor
Friction Pulley
Adjustable Boxes
Adjustable Ram Guide Fitting
Main Frame One Solid Casting
Treadle Relief Spring on Other Side
Motor
Mayer Bros Mankato Minn

Little Giant Power Hammers

Will manufacture, reshape and sharpen pick points, chisel bits, puncher picks and all other mining tools, when used with our special discs in adition to taking care of your blacksmith work;

Operated by one man will do the work of three to seven huskies and pay for itself every one hundred hours or so of steady work;

Run with machine gun rapidity and precision, and without vibration;

Will make better tools and do your work better than you have known before;

Are sold by legitimate dealers in mining equipment and supplies;

Are guaranteed Forever against defective material and workmanship;

Are sold subejct to return at factory expense after 30 days use, if for any reason unsatisfactory, and no questions will be asked;

Have been made and sold for 24 years by a firm that commenced business in January, 1876,—41 years ago.

Specifications	25 Lb.	50 Lb.	100 Lb.	250 Lb.	500 Lb.
Will forge stock up to..	1½ sq. or 2 rd.	2 sq. or 2½ rd.	3 sq. or 4 rd.	5½ sq. or 7 rd.	7 sq. or 9 rd.
Upper die size of face...	1½"x3"	1¾"x3½"	3"x6"	3½"x8"	4½"x10"
Lower die size of face...	2"x3"	2½"x3½"	3"x6"	3½"x8"	4½"x10"
Lower die length of base.	5"	5½"	6"	8"	10"
Variable length of stroke.	6" to 7"	8" to 11"	9" to 12"	12" to 15"	14" to 19"
Throat room..........	6"	6"	7¾"	13"	15"
Weight of steel ram.....	25 lbs.	50 lbs.	100 lbs.	250 lbs.	500 lbs.
Weight of ham. comp...	800 lbs.	1600 lbs.	3300 lbs.	5000 lbs.	7000 lbs.
Height over all........	5 ft. 4 in.	5 ft. 11 in.	6 ft. 6 in.	7 ft. 6 in.	9 ft.
Floor space required....	16"x27"	20"x30"	28"x42"	30"x54"	32"x62"
Belt pulley size........	3½"x10"	4"x12"	5"x14"	8"x18"	9"x24"
Revolutions per minute...	400	350	300	200	150
Estimated H. P. required	¾	1½	2½	4	7½
Price	$100	$150	$300	$750	$1250
Code word..........	Babe	Boy	Man	Giant	Jumbo
Special					
Pick pt. dies-cd. wd Pick	$25	$25	$35	$50	$75
Chisel bit dies-code word "Chibi"	not used	$65	$75	$90	$110
Com. pick point and chisel bit dies-code word "Pichi"	not used	$75	$85	$100	$125
Puncher pick dies-code word "Punch".......	not used	$65	$75	$90	$110
Motor Equipment					
Price, ex. com. with mot.	$150	$190	$225	$270	$400
Motor furnished-code word "Motor"	1 H. P.	2 H. P.	3 H. P.	5 H. P.	7½ H. P.
Weight, Extra					
Shipped with hammer...	180 lbs.	260 lbs.	310 lbs.	450 lbs.	700 lbs.
To equip used hammer..	230 lbs.	320 lbs.	520 lbs.	700 lbs.	1000 lbs.

Motor quotations include 110 or 220 V. 3 phase, 60 cyc. 1200 R. P. M. A. C. Motors. **Quotations** by request on other A. C. or D. C. Motors. Prices above f. o. b. Mankato, Minn.

Special dies for any forging purpose. Prices quoted on receipt of drawings or sample of work to be done. Above prices are subject to change without notice.

Little Giant Power Hammers

Are used by over 1000 coal mines, including the largest companies, many of whom have sent repeat orders and now use from three to twelve of them, whose names and addresses will be furnished upon request;

Are designed to protect the operator in every possible manner against personal injury;

Will never wear out and will run at low upkeep expense,—our 1916 repair sales on all in use from the oldest to the newest averaged less than ⅖ or 1% of original cost to purchasers.

Reasonably prompt shipments of all sizes and models are being made.

Write your jobber or direct to us.

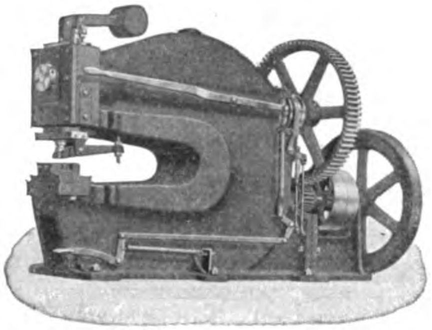
SOMERS, FITLER & TODD CO.

327 Water Street PITTSBURGH, PA. 323 First Avenue

Complete Equipment for Mine Shops

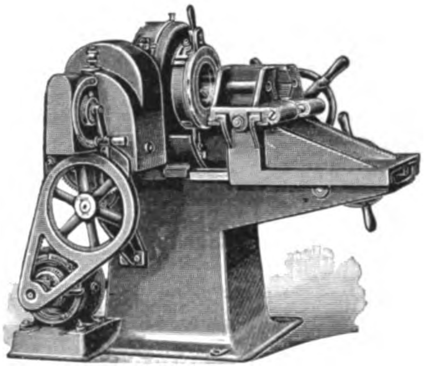
Pipe Machines
Power Hack Saws
Punches and Shears
Radial Drills
Upright Drills
Power Hammers
Lathes
Shapers
Band Saws
Floor Grinders
Portable Electric Tools
Portable Cranes

STANDARD PUNCHES AND SHEARS



Made single or double with either top or bottom drive. We furnish Punching and Shearing Tools in all capacities to suit all classes of work as specified. Complete data and price list on request.

PIPE MACHINES



Motor Driven or Belt Driven

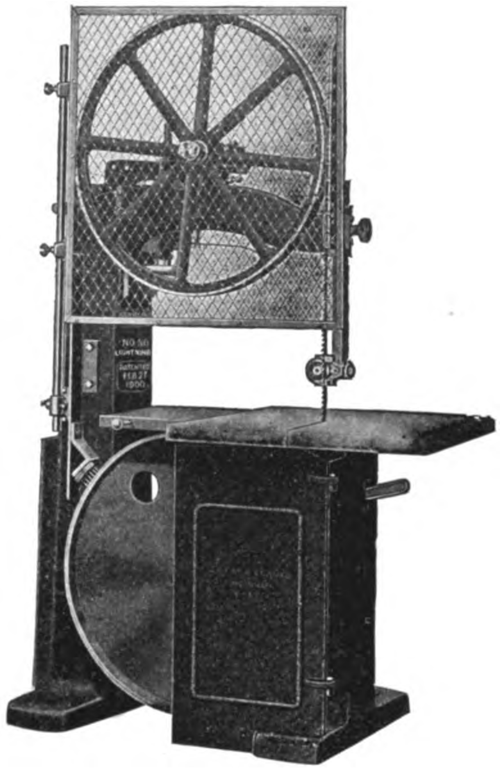
Capacities, 1/4 to 2, 1 to 4, 1 1/4 to 6 and 2 1/2 to 8 inch pipe.

Hand Machines

Capacities, 1 1/4 to 2, 1 to 4, 1 to 6, 2 1/2 to 4 and 2 1/2 to 6 inch pipe.

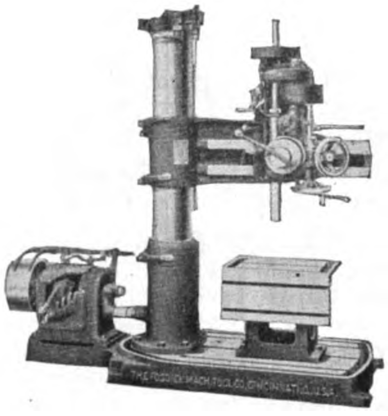
Complete specifications and prices on application.

36-INCH BAND SAW



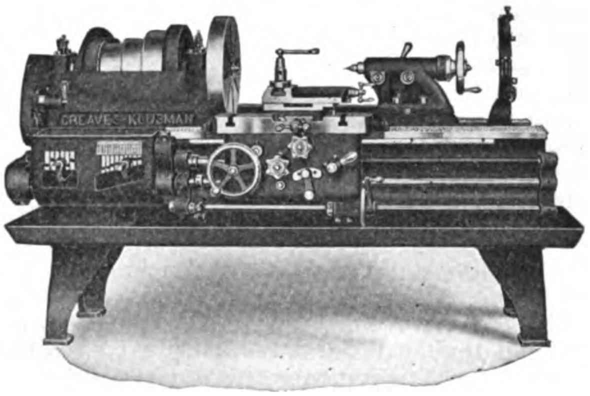
Furnished complete with all equipment and safety guards in compliance with workmen's compensation laws. All sizes from 20″ to 40″ wheels. Complete specifications and prices on application.

HEAVY DUTY RADIAL DRILL



Furnished in all sizes from from 2 to 6 foot arm. Catalog showing complete line of Radial Drills mailed on request.

ENGINE LATHE



Heavy Quick-Change Type

With Three-Step Cone and Friction Double Back Gears.

Furnished promptly in 16, 18, 20, 22, 24 and 30 inch sizes.

Specifications and prices on application.

We Are Also Large Distributors of Mill, Mine and Manufacturers' Supplies.
1200-Page General Machinery and Supply Catalogue Furnished on Request.

DAVIS-BOURNONVILLE CO.

General Offices and Factory, Jersey City, N. J.

NEW YORK
BOSTON
PHILADELPHIA
PITTSBURGH

CLEVELAND
CINCINNATI
CHATTANOOGA

OXY-ACETYLENE WELDING
DAVIS
APPARATUS
DAVIS-BOURNONVILLE CO. N.Y.

CHICAGO
DETROIT
ST. LOUIS

SEATTLE
SAN FRANCISCO
LOS ANGELES
TORONTO, ONT.

Oxy-Acetylene Welding and Cutting Apparatus
Acetylene, Oxygen and Hydrogen Generating Plants

"Davis Apparatus" affords the Widest Range of Equipment and the Highest Efficiency of any Oxy-Acetylene and Oxy-Hydrogen Welding and Cutting Apparatus made—backed by the longest service and greatest success in development and in practical experience.

Complete installations with gas producing plants for the largest users, and portable outfits for emergency repair work and occasional users.

Invaluable for welding broken castings, machinery, tools—cast iron, steel, aluminum, brass or other metals—and for cutting steel. It is a money-saver in every repair shop and power department, restoring broken machinery to commission quickly, effectively and economically, often saving long delays and consequent loss of earning power waiting for new parts, and the cutting equipment is of inestimable value in wrecking and scrapping.

Stationary Plants

The most economical operation in general repair shops and for manufacturing is provided with generation of the acetylene on the premises. A stationary plant will include an acetylene generator and as many welding and cutting units, or stations, as are required. The Davis Acetylene Pressure Generator is the result of twenty years experience in successful acetylene generator construction, and is listed by the National Board of Fire Underwriters. It is made in five sizes, from 25 cubic feet up to 300 cubic feet output of acetylene per hour. The generators are automatic, the feeding mechanism controlled by the gas as generated, requiring attention only when necessary to refill with carbide and water. Gas is delivered to the several operating stations by pipe line, under direct pressure from the generator up to 15 lbs. Oxygen may be produced on the premises when required in sufficient volume, or may be readily and economically obtained in portable tanks from central producing plants distributed throughout the country.

Welding and Cutting units include the welding and cutting torch, with interchangeable tips for light, medium and heavy work, acetylene and oxygen regulating and reducing valves with pressure gauges to indicate the storage pressure and the reduced working pressure, special acetylene and oxygen hose connecting torches to regulators.

Portable Outfits

The most portable outfits for both welding and cutting employ the welding or cutting units with portable tanks, or cylinders, in which acetylene and oxygen is compressed. Both acetylene and oxygen may be obtained in this form from large producing plants with distributing depots in various parts of the country. The welding or cutting unit, or outfit, comprises the torch, with interchangeable tips for light, medium or heavy work, acetylene and oxygen regulating and reducing valves with pressure gauges indicating the contents of the tanks and the working pressure, suitable lengths of hose connecting torches and regulators, and a two-wheel truck for moving the complete equipment.

There is a Davis-Bournonville torch and tip for every requirement in welding and cutting. Standard welding torches are made in four sizes and each size can be furnished with either 45°, 75° or 90° head, cutting torches in two styles, with different angle heads. All Davis-Bournonville torches use both the acetylene and oxygen under independent, positive pressure, and tips are so accurately drilled that the neutral flame proportioning of gases is positively maintained in all sizes, at determined pressures. The success of the Davis-Bournonville torch has made it the standard of efficiency.

Davis-Bournonville Apparatus leads the world in range, efficiency, and number of successful users. It is extensively and profitably employed by the largest iron and steel mills, foundries, ship-building yards, locomotive and car builders, automobile factories, sheet metal workers, in all U. S. navy yards, on the Panama Canal, in government arsenals and other departments, in a great many mines and hundreds of general repair shops. Efficient consulting service is given in determining the capacity of plant best suited to the requirements.

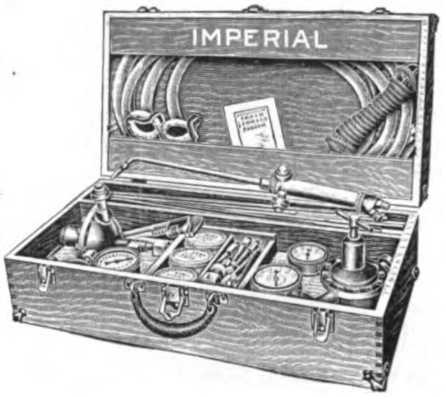
THE IMPERIAL BRASS MFG. CO.

508 South Racine Avenue
CHICAGO

Manufacturers of

Oxy-Acetylene Welding & Cutting Equipment

When castings, machinery or tools break, Imperial equipment can be used to repair them on the spot without delay. An ordinary mechanic can readily learn to operate the torch, which is safe, portabe and economical. Imperial torches weld anything in metal, cut anything in wrought iron or steel.



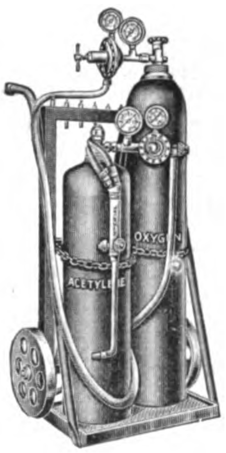
Welding Outfit in Carrying Case.

No other torch has a mixing principle like the IMPERIAL—scientific, practical, years ahead. IMPERIAL TORCHES are approved by the Underwriters' Laboratories of the National Board of Fire Underwriters. No other regulator so accurately and uniformly controls delivery of gases—none has its automatic safety features.

No. 1 Welding Outfit

For all general welding work, from thin sheet metal to heaviest castings. Consists of Type B welding torch with ten welding tips, extension, decarbonizing torch, regulators, gauges, hose, connections, goggles, complete supply of welding materials, ready for service.

Weight, approximately 75 lbs. Net, each $60.00.



Portable Truck.

No. 3 Cutting Outfit

For light and heavy cutting, from tin sheet metal to the heaviest structural iron and similar work. Consists of Type E cutting torch with two housings and four tips, regulators, gauges, hose, connections, goggles, etc., complete, ready for service. Weight, approximately 65 lbs. Net each $75.00.

Welding Broken Casting.

No. 4 Combination Welding and Cutting Outfit.

A splendid equipment for all general work, repair shops, etc. Combination welding and cutting torch performs both operations with one torch. Consists of Type B welding torch with Imperial cutting attachment, ten welding and three cutting tips, decarbonizing torch, regulators, gauges, hose, connections, goggles, complete supply of welding materials, ready for service. Weight, approximately 80 lbs. Net, each $80.00.

No. 5 Duplex Welding and Cutting Outfit.

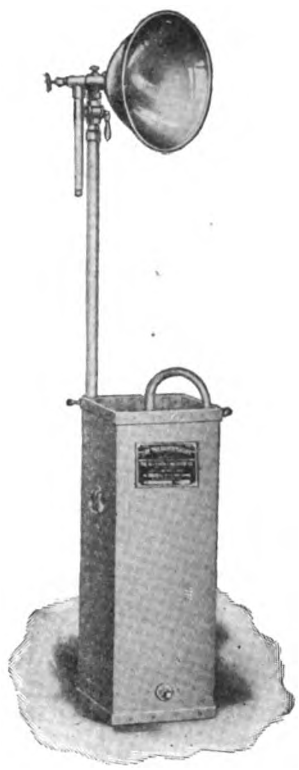
This is a combination of the Nos. 1 and 3 outfits for both welding and cutting and is the best all-purpose apparatus obtainable at any price, being fully adequate to handle all kinds of welding and cutting within the limits of the process. Consists of a complete No. 1 welding outfit as described, and also includes a type E cutting torch with two housings and four tips and an extra pair of goggles and 25-foot lengths of hose. Weight, approximately 90 lbs. Net, each $95.00.

Trucks

For use with Imperial Welding and Cutting Outfits. A great convenience when outfit is to be frequently moved around shop or yards and prevents breakage of equipment. Net, each $10.00.

THE ALEXANDER MILBURN CO.

BALTIMORE, MD.
BRANCH OFFICES
NEW YORK, AND PITTSBURGH
Manufacturers of
Portable Carbide Lights, Oxy-Acetylene Welding and Cutting Apparatus,
Mine Lighting Equipment, Gas Plants for Industrial Buildings



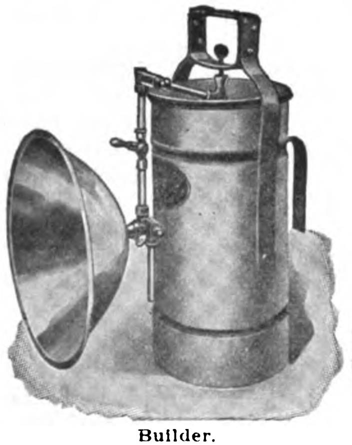
No. 8.
5,000 Candle Power for 12 Hours.
Cost 3 Cents Per Hour.

General

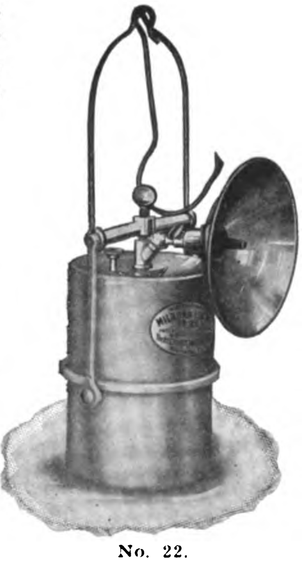
The first and chief aim of Milburn Lights is a low operating cost combined with efficient and dependable service. This is made possible through the use of 100% pure commercial lump carbide, obtainable practically everywhere in the United States and Canada. We have nothing to sell but lights, carbide for Milburn Lights being bought in the open market from any of several carbide manufacturing companies. Lights using carbide in the form of cakes which is also sold by concerns manufacturing lights, operating only on cake or special forms of carbide, are more expensive in the long run and cannot give the service that Milburn Lights can, owing to the fact that lump carbide at approximately 4 cents per pound yields 5 feet of gas per hour, while cake carbide at 6 cents per pound yields less gas.

Uses

Wherever there is night work there is a big opportunity to improve results and cut costs with Milburn Portable Carbide Lights, the lights that use universal fuel. On construction work, in mining, quarrying, lumbering, railroad or marine service, or some part of a manufacturing plant, the use of Milburn Lights will get a greater output from men and equipment.



Builder.
500 Candle Power.



No. 22.
100 Candle Power.

Points of Excellence

Milburn Lights are entirely automatic, operating either continuously or intermittently, with no over-generation of gas, either while the light is turned off or while the light is burning. They are extremely simple and are easily understood by an ordinary laborer. They are substantially built throughout, having no pumps, gauges, mantles or delicate parts, and consisting of but four parts—tank, gas bell, tray and tray container.

Portable Cylinder Plant.

Milburn Oxy-Acetylene Welding and Cutting Outfits

Outfits for every requirement from small portable repair outfits for garages and repair shops to large Oxygen and Acetylene generating and compressing installations for United States Navy Yards. Milburn Welding Generators make acetylene gas right on the job, replacing storage tanks and cutting the cost about 50 per cent.

Welding and Cutting Torches

Separate Milburn torches may be had for welding or cutting or a single torch may be had for both operations. The gases are mixed in the tip, producing a flame of great uniformity, which is essential for best results. Flashback is entirely eliminated from all torches.

THE PREST-O-LITE CO. INC.

U S. Main Office and Factory-Indianapolis Ind. U. S. A.
Canadian General Office-Toronto, Ontario

Direct Factory Branches

Atlanta
Baltimore
Boston
Buffalo
Chicago
Cincinnati
Cleveland
Dallas
Davenport
Denver
Des Moines
Detroit
Indian Orchard (Near Springfield, Mass.)
Indianapolis
Jacksonville
Kansas City
Los Angeles
Memphis
Merritton
Milwaukee
Minneapolis
Montreal
New York
Omaha
Philadelphia
Pittsburgh
San Francisco
Seattle
Syracuse
St. Louis
St. Paul
San Antonio
Winnipeg

The World's Largest Makers of Dissolved Acetylene

Products

Prest-O-Lite Acetylene for lighting, oxy-acetylene welding and cutting, and all commercial purposes.

Apparatus and supplies for welding, cutting, brazing, heating and lighting.

Deep drawn seamless steel shells and cylinders. Pressed, spun and drawn steel shapes.

Prest-O-Lite Storage Batteries for every make and model of pleasure car or truck.

Oxy-Acetylene Welding and Cutting

This process is the one distinctly successful method of fusion welding. The oxy-acetylene flame quickly unites two pieces of metal, making one homogeneous piece of metal. Oxy-acetylene welding largely eliminates the use of rivets, bolts and threaded joints in the construction of thousands of metal products and corrects mistakes in design, remedies defects in castings, and reclaims damaged or worn euqipment.

With a special blow-pipe, oxy-acetylene cutting can be done along any line—circle, curve, bevel or other line and leave a sharp, clean cut through the metal.

Prest-O-Lite Acetylene Serivce

As the world's largest makers of dissolved acetylene, with a net-work of Factory Branches, Charging Plants and Service Stations literally covering the country, The Prest-O-Lite Co., Inc., insures prompt, universal, perpetual acetylene service for all purposes and in any quantity.

Prest-O-Lite Style	Length (Ins.)	Diameter (Ins.)	Capacity (Cu. Ft.)	Average Weight (Lbs.)
MC	13½	4	10	8.9
E	16	6	30	26.8
B	20	6	40	32.4
A	22	7¼	70	44.5
WC	33	8	100	85.
WK	38	12	300	220.

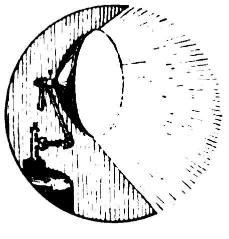
Full compliance is made with all the regulations of the Interstate Commerce Commission, the Bureau of Explosives, etc.

Expert advice by the Prest-O-Lite Engineering Department on any oxy-acetylene welding or cutting operations is always a part of the Prest-O-Lite Service. Valuable suggestions, such as improved methods of handling different welding or cutting operations, and instructions on welding work previously unthought of, or regarded as impractical, are offered to customers.

At important centers staffs of skilled men are maintained. These experts are at the disposal of users of Prest-O-Lite Acetylene and are ready at all times to give practical advice and assistance on welding or cutting problems.

Portable Flare Lamp

The illustration shows a portable outdoor flare light, suitable for rush work at night. Pierces rain, dust, fog or smoke. This small light is furnished in two styles. Used with a carrier for "MC" Prest-O-Lite and swung over the arm. Outfit stands 18 inches high and weighs 18 lbs. Price complete with Prest-O-Lite, $25.00 (Canada, $30.00). Ten-inch aluminum reflector and burner only, as shown, with arm for attaching to automobile style Prest-O-Lites. Price, $15.00 (Canada, $16.50).



Advantages of Prest-O-Lite

Prest-O-Lite Acetylene Service furnishes the purest form of dissolved acetylene (ready-made carbide gas) in portable cylinders of convenient size—used as conveniently as cylinders of oxygen. Saves the large initial outlay and heavy depreciation, trouble and inconvenience of making crude acetylene in carbide generators. When acetylene is needed there is no delay in generating gas, simply turn on the Prest-O-Lite at the cylinder valve and use it.

Absolute Safety. A Prest-O-Lite will go through a fire without exploding, because safety plugs in both ends of cylinder will melt allowing the gas to escape and burn harmlessly at the opening. In winter there is nothing to freeze.

A Few Uses for Prest-O-Lite Gas

Oxy-Acetylene Welding and Cutting for iron and steel constructive work. Repairing broken or worn metal machine parts and tools. Reclaiming defective castings. Rail Bonding. Cutting scrap and structural iron and steel.

Portable Lights, for fire departments, construction work, dredges and railroad wrecks.

Acetylene Blow Torches, for soldering, brazing and lead-burning.

There are hundreds of profitable uses for Prest-O-Lite. Write for descriptive bulletins and engineering data. Free.

Prest-O-Lite Welding Apparatus

This high-grade, portable welding equipment provides necessary apparatus for handling the widest range of light or heavy welding in manufacturing construction and repair work. Employs Prest-O-Lite Dissolved Acetylene and compressed oxygen, in convenient size cylinders.

Welding apparatus consists of an equal pressure blow-pipe, automatic regulators and gages for acetylene and oxygen cylinders and the necessary sundries. Price, $75.00 (Canada $100.00). Truck for carrying acetylene and oxygen cylinders and special apparatus for metal cutting furnished at extra cost. Any average workman who understands metals can quickly learn this welding process.

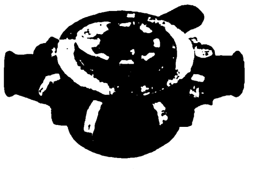
Welding Outfit Mounted on Truck.

THE BORDEN COMPANY

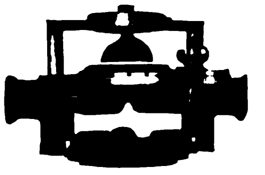
Warren, Ohio, U. S. A.

BEAVER

Easy Working Die Stocks

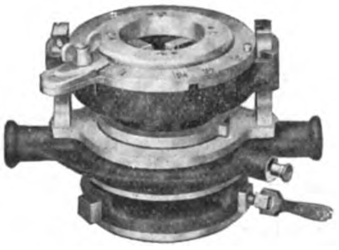


No. 6 (¼ to ¾ in.) Beaverette
No dies or bushings to change. A sturdy little tool that's always ready. List $15.00. Extra dies, per set, $3.00.



No. 210 (½ to 1¼) Cross-Bar
An Easy Working Receding Die Stock without loose parts. As strong as a solid die, but easier to operate. List $20.00. Extra dies $5.00.

No. 25 (1 to 2 in.) Beaver
No dies or bushings to change. No loose parts! Will outwear many sets of cheaper tools. List $30.00. Extra dies $3.50.



No. 26 (1 to 2 in.) Ratchet
Like the No. 25, except operates with ratchet. Preferred for mining operation and work in confined positions. No loose parts. List $35.00. Extra dies $3.50.

"Move the Handle—That's all!"—is the slogan of Beaver Easy Working Die Stocks. This means that you—or your men—do not have to change dies and bushings every time you go from one size pipe to another.

With Beavers—you need not change dies at all in tools cutting up to four-inch; nor are bushings used in tools below two-inch.

The best recommendation that could be given Beaver Tools would be a list of their users. This list would include the largest user of pipe in the United States (Nothing but Beavers)—most large Contracting Firms, Railroads, Coal Mines, and the most successful Plumbing and Heating concerns in this country. The United States Government specified Beaver Tools.

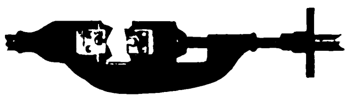
SQUARE-END PIPE CUTTERS

The Beaver Square-End Cutter meets the demand for a real Pipe Cutter. The cutting is done by two tool-steel knives which "turn" out a thin shaving of metal until the pipe is severed. The adjustment of the knives is entirely automatic and fool proof. A Beaver is safe in the hands of the greenest apprentice or of the roughest user.

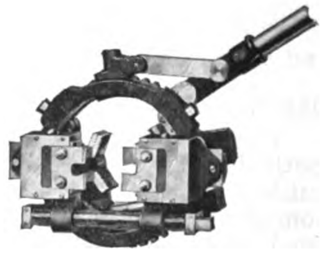
The Beaver Square-End Pipe Cutter gives an absolutely square-end cut, as indicated by its name. No ragged burr is left on the inside of the pipe—no rough ridge on the outside. Reaming and filing are not necessary. Quite a saving in a year—more than enough to pay for several Beaver Cutters.

BEAVER GUARANTEE

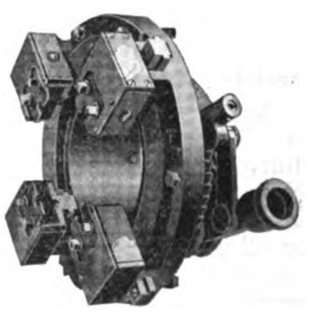
Every Beaver tool is not only guaranteed against defects, but is guaranteed to satisfy in every respect. "The user must be pleased"—that's the Beaver policy.



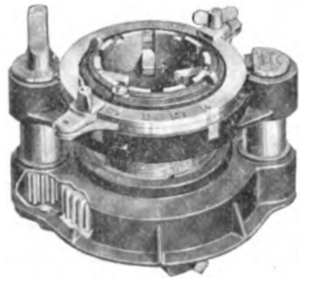
No. 1 (⅛ to 1) Cutter
No. 5 (½ to 2) Cutter
We recommend the No. 5 for mine use, as it cuts all sizes from ½ to 2 inch.
List price, No. 1, $18.00.
List price, No. 5, $20.00.



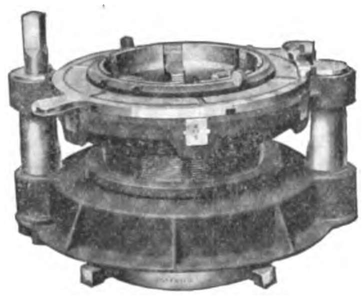
No. 10 (2½ to 4 in.) Cutter.
Can be "broken" to permit placing over pipe line. List price, $90.00.



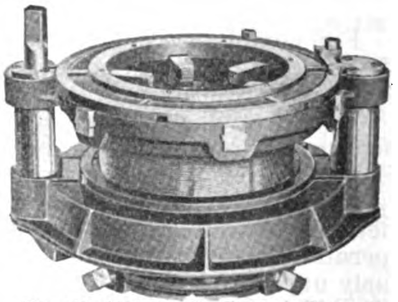
No. 15 (2½ to 6 in.) Cutter
This 2½ to 6 inch Beaver cutter is a new tool—a natural development from the No. 10 shown above. List price, $180.00.



No. 41 (2½ to 4) Geared Beaver
A light, strong tool, threading all sizes 2½, 3, 3½ and 4, without changing dies. Particularly adapted to mine work. A husky boy can cut 4 inch. List $110.00. Extra dies $9.00.



No. 61 (2½ to 6) Geared Beaver
More of these are sold than all other 6-inch hand machines combined. Two sets of dies are used to cut the unusually large range. All steel construction and guaranteed to outwear cheaper tools. List $220.00. Extra dies per set $14.00.



No. 80 (4½ to 8) Geared Beaver
No. 90 (9 to 12) Geared Beaver
We guarantee one man can cut up to 12 inch pipe. Built like other large Beavers of steel for service. 2 sets of dies are used. Light enough to be easily portable.

No.	List	Dies
80	$300.00	$20.00
90	500.00	30.00

The Toledo Pipe Threading Machine Co.

1445 Summit St. Toledo, Ohio
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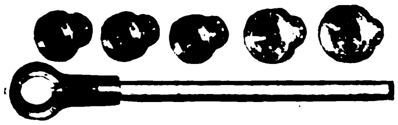
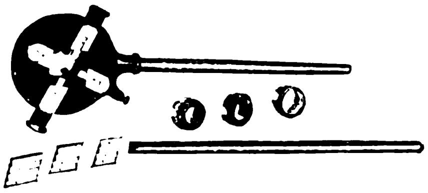
Manufacturers of

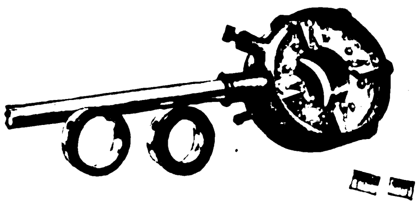
TOLEDO HAND OPERATED PIPE THREADERS



Toledo No. 00—⅛" to ¾" Ratchet Threader. Simplest, handiest small tool in use to-day.
List Price, Comp., $20.00



Toledo No. 1A—1" to 2" Ratchet Tool for close quarter threading.
List Price, $30.00



Toledo No. 1½R—2½" and 3" Tool operated by a ratchet, but not geared.
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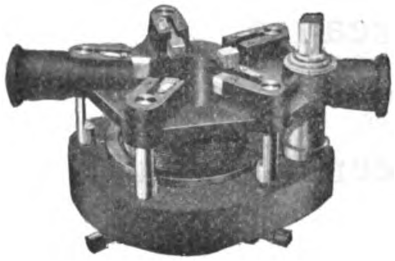

Toledo No. 2—2½" to 4" Geared Threader that is a one-man tool.
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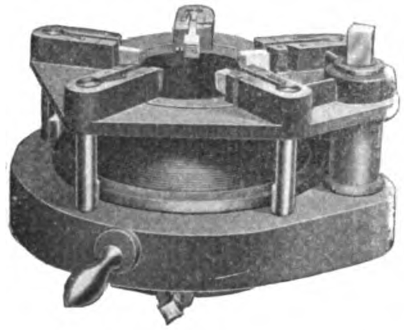

Toledo No. 3—4½" to 8" Geared Tool that is portable and operated by one man.
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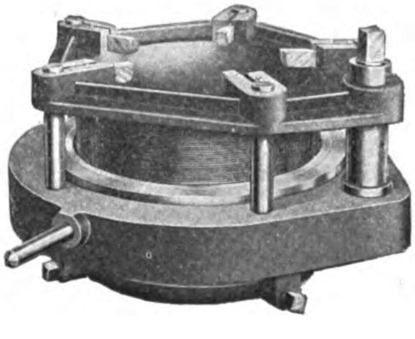

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"Toledo" Pipe Threaders—

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There are more than a dozen different models, having a range from ⅛" to 12", and among them you will be sure to find the tools that will just meet your needs.

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That actually cut the pipe off, leaving no burr, but a straight, clean cut are a part of the "Toledo" line.

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Will hold without crushing or marring any shaped fitting or valve that will go between the jaws.

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Treatise
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EXPLOSIVES

By Robert M. Black.*

It is natural to associate explosives with destruction, but their use in construction and upbuilding has been a large factor in the history of civilization. They have been essential in making the excavations for many railroads, canals, and buildings, they have assisted in agriculture, they have made quarry work easy, they have limited conflagrations and they have made possible economical mining.

Primitive mines appear to have been surface accumulations of gems or minerals, which were loosened with pointed sticks. The ancients later used alternate applications of fire and water to loosen the valuable mineral, or rock containing it. Such methods could not produce a quantity of mineral sufficient to meet the growing demands. Nor did the best of the early methods penetrate beyond very shallow depths, unless the material happened to be exceptionally rich and easy to work. While there are some substitutes for explosives now used in a limited way in mining practice, still the history of mineral production shows the dependence of the industry on explosives. Increased use has brought about improvements in composition, in facilities for use, in safety and in cost, most of which development has taken place within comparatively recent times. Explosives are to be credited not only with the large production of mineral generally, but also with the entire production of certain minerals that occur under conditions rendering them difficult or impossible of winning otherwise. Practically all the coal mined in the United States is broken from the seam by the use of explosives.

The oldest explosive is believed to be gunpowder, but the date of its invention and the name of the inventor remain uncertain. A document still preserved at Florence, Italy, relating to the manufacture of cannon, refers incidentally to gunpowder. The date, February 11, 1326, marks the first unquestioned reference to the use of gunpowder in Europe. Roger Bacon, the English philosopher, who lived in the thirteenth century, writes of a mixture composed of saltpeter, charcoal and sulphur in proportions similar to those of gunpowder, "producing noise like thunder and flashes like lightning". It seems to have been regarded at that time as a curiosity, and its applications to useful work were unknown. There is some reason to refer the invention of gunpowder back to more ancient time, when, according to the views of some, the Chinese, Greeks and other races had substances resembling it, but the evidence is by no means conclusive.

DESCRIPTION OF EXPLOSIVES

An explosive is defined as a substance capable of extremely rapid decomposition into a relatively large volume of gases under the action of either heat or shock. Combustion is the union of any element with oxygen, a familiar example of which is the burning of wood, the carbon of the wood uniting with oxygen to form gases. The gases in this case are formed slowly, and have abundant opportunity to pass off into the atmosphere without disturbance. If the rate of formation of the combustion gases is rapid, and if the volume of such gases is much greater than can be contained in the space formerly occupied by the combustible substance, then the pressure on the inside of the space containing the gases is so great that the enclosing material is ruptured and fragments are thrown to varying distances. The pressure is further increased by the heat of combustion expanding the gases formed.

Gunpowder

The essential feature of an explosive being the production of a large volume of gases from a small volume of the substance, materials have been sought that would give the most efficient results. While oxygen from the air is sufficient to support ordinary combustion, the supply is not great enough to produce the volume of gases necessary to do the work of an explosive. Some source of concentrated oxygen is, therefore, required, and for this purpose, saltpeter, or potassium nitrate (KNO_3), suggests itself. This substance is found in nature in various places on the globe, but it seems to have been observed originally in India, and for that reason is sometimes known as India saltpeter. The substance selected for the combustible was charcoal, which is composed chiefly of the element carbon. In the process of combustion, charcoal contributing carbon and saltpeter contributing oxygen, gases composed of carbon and oxygen atoms are formed, chiefly carbon dioxide (CO_2), but with some carbon monoxide (CO) where combustion is incomplete. The problem was to start the combustion. Carbon and oxygen do not unite at ordinary temperatures, but only at a high temperature. To obtain the heat most easily, sulphur was added to the mixture. Sulphur burns readily, and in doing so, produces a temperature sufficiently high to effect the union of carbon and oxygen atoms. The mixture described is known as gunpowder, because it was early applied to use in guns. The standard proportions for the ingredients are 75 parts potassium nitrate, 15 parts charcoal and 10 parts sulphur, all in terms of weight.

It is necessary that the ingredients be thoroughly mixed, in order that each particle of combustible may have as close to it as practicable a particle of oxygen. The nitrogen of the potassium nitrate is liberated as gas, and the potassium combines with the sulphur to form potassium sulphide (K_2S), a solid product, approximately one-third the volume of the gunpowder.

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*Associate Professor of Mining University of Pittsburgh.

Other nitrates than potassium nitrate might meet the requirements for supplying oxygen, and efforts have been made to find an efficient substitute, which would at the same time have the advantage of being cheaper. About 1870, sodium nitrate ($NaNO_3$) was first used, and found to be successful from these standpoints, where its property of absorbing moisture was not detrimental. As this substance came chiefly from Chile, it has been known as Chile saltpeter. For use in guns, the potassium nitrate powder is preferred, because it keeps drier, and therefore, in better condition for use after long periods of preservation.

Black Blasting Powder

For a blasting powder, either of the two saltpeters may be used, but the consideration of economy favors the sodium nitrate. Powders made from either saltpeter are known commonly by the name of black powder, or blasting powder, that containing potassium nitrate being usually designated by manufacturers as "A", and that containing sodium nitrate as "B". When sodium nitrate is used, the proportions of the mixture are slightly different, namely, 73 parts sodium nitrate, 16 parts charcoal, 11 parts sulphur. The difference is due chiefly to the fact that the oxygen content of sodium nitrate is greater than that of potassium nitrate. In each case, the intention is to provide just enough oxygen to consume the carbon and sulphur.

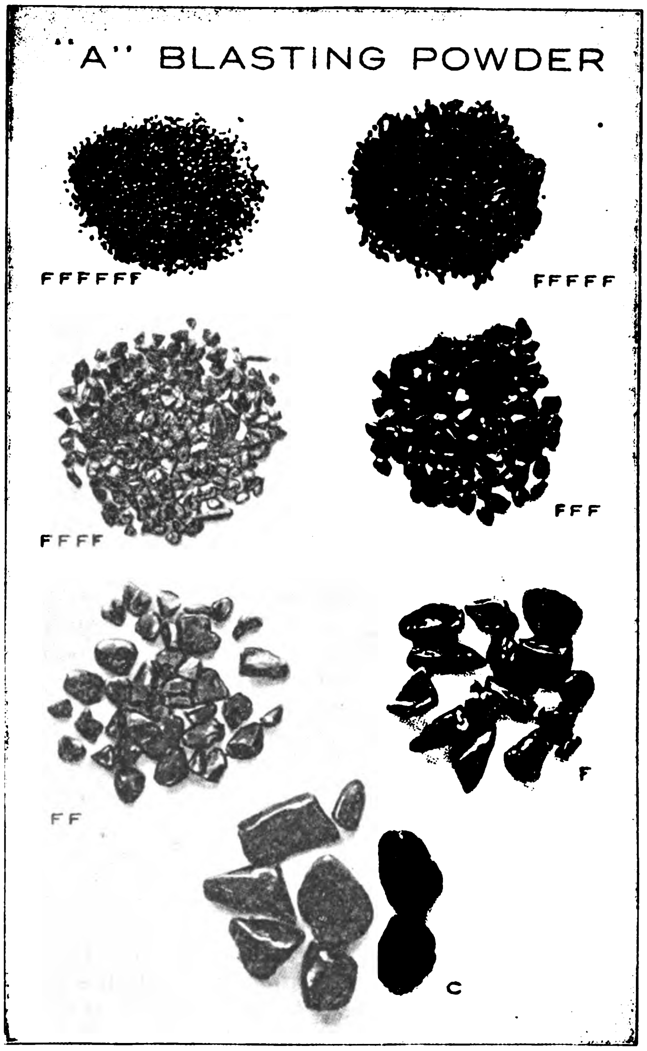

Fig. 1—Sizes of "A" Blasting Powder.

Blasting powder is marketed in granular form, "A" powder, Fig. 1, usually in seven different sizes, and "B" powder, Fig. 2, in the same number, each size being designated by one or more letters. In general, the sizes of "A" and "B" powders do not correspond, the "B" averaging larger than the "A".

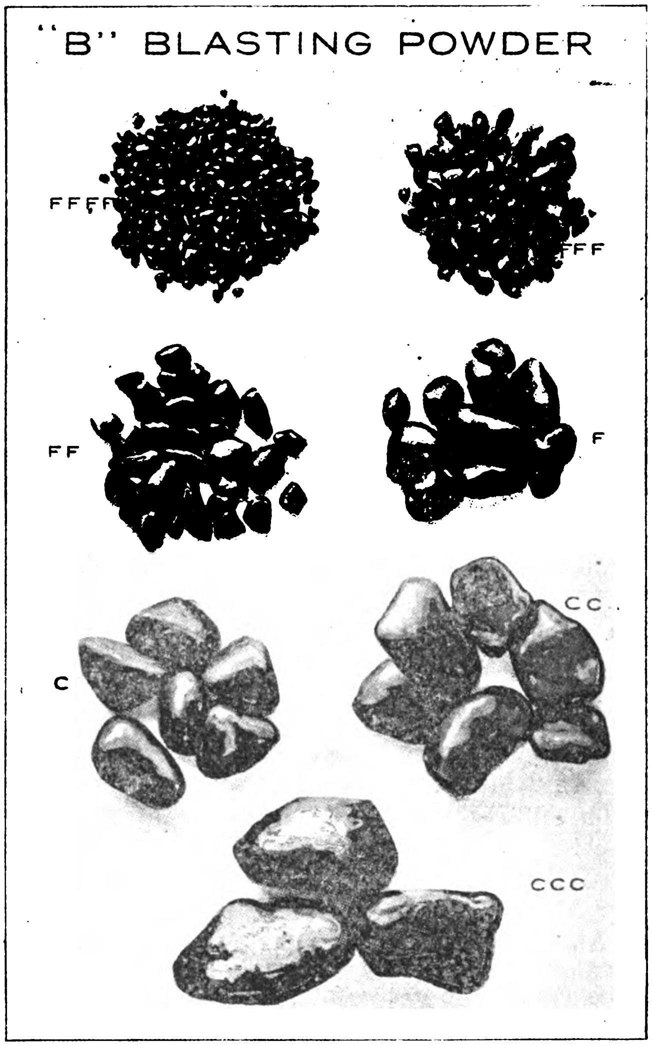

Fig. 2—Sizes of "B" Blasting Powder.

The powder is packed in sheet steel kegs, usually of 25 pounds capacity, although the use of fibre for the material of the container is also in favor. The chief advantage of the latter is that it is a nonconductor of electricity, and is, therefore, safer for transportation in cars hauled by electric locomotives. If the powder is received in metal containers, it may be transferred to fibre containers, provided with bail handles and designed specially for such transportation. The latter are known as electrical pails, and are used for other explosives, as well as blasting powder. The same material has been employed in making powder flasks for the individual miner, these being of the maximum capacity permitted by law, usually five pounds.

The sizes of powder are carefully separated at the factory, and grains of one size only are shipped in one container. The chief purpose of this precaution is to insure, as far as possible, uniformity in rate of burning. If grains of different sizes were mixed, the smaller grains would burn more quickly, and tend to throw the larger grains in an unburned or incandescent state out of the hole. Under some circumstances, the result would be only a waste of the larger grains, but if explosive gas were present, as is often the case in coal mines, the danger of igniting it would be very great. Another advantage of uniform sized grains is the standardizing of results, which makes possible the selection of powders suited to certain requirements. The grains are usually glazed with graphite to render them more impervious to moisture. Fine grained powders are quicker, and tend to shatter the material more, while coarse grained powders are slower and have more of a lifting effect.

Chlorate Powder

Oxygen may be obtained from other compounds beside nitrates, and many efforts have been made to adapt such substances to use in explosives. Some success has been attained with potassium chlorate (KCO_3), but the liability of this substance to explode on slight friction has prevented its general use. Methods have been devised, however, of restricting this tendency by mixing with certain other substances, such as starch, and the results have been satisfactory.

Nitroglycerin

Oxygen may be made to unite chemically with certain substances by treating the substances with nitric acid (HNO_3). The nitric acid is manufactured from either of the saltpeters, and contains the same quantity of oxygen as the saltpeter. One substance frequently treated with nitric acid for this purpose is glycerin, $C_3H_5(OH)_3$, the result of the nitration being a compound known as nitroglycerin, $C_3H_5(NO)_3$. In this process, sulphuric acid is first run into nitric acid, then glycerin into this mixture, the heat of the reaction being dissipated by careful stirring and sometimes artificial cooling. The nitroglycerin formed is separated from the acid by pouring into cold water, and is then purified.

Nitroglycerin is a colorless, oily liquid with specific gravity about 1.6. It freezes at a temperature of about 55° F., and is evaporated by heating, but at 306° F., explodes by reason of the temperature alone. It is poisonous to the human system internally and externally, but the danger from contact poisoning diminishes with continued handling. It is exploded ordinarily by shock, and is very sensitive to shocks; therefore, is especially dangerous to handle. In the liquid condition, it is little used, but when associated with certain solid substances, its properties may be employed with reasonable safety. Nitroglycerin is among the most important of all explosives commercially.

There are two general classes of explosives, represented respectively by gunpowder and nitroglycerin, and known as low and high explosives on account of the difference between their effects. The same classes are known as deflagrating and detonating explosives, because of the manner of their ignition. High explosives are more rapid and more powerful than low explosives.

Dynamite

Nitroglycerin is used most in connection with an absorbent material, or dope, such as wood meal or infusorial earth, and the mixture is known as dynamite. Its specific gravity is about 1.4. Dynamite possesses the properties of nitrogylcerin, but is safer to transport and handle than the liquid. Dopes may be inactive, as those mentioned above, or they may be active, and contribute to the explosion of the dynamite. An example of active dope sometimes used is gunpowder. Dynamite and other nitroglycerin mixtures are graded according to their strength by percentages of nitroglycerin, or its equivalent, present in the mixture. The usual range is from 15 per cent. to 60 per cent. For purposes of comparison, the United States Bureau of Mines has adopted as its standard straight dynamite a mixture of 40 per cent. nitroglycerin, 44 per cent. sodium nitrate, 15 per cent. wood pulp and 1 per cent. calcium carbonate.

For commercial use, dynamite is packed in paraffined paper cartridges, 8 inches long and usually 1¼ or 1½ inches in diameter. The cartridges are packed in wooden boxes, each containing 25 or 50 pounds.

The products of combustion of 200 grams of standard dynamite are stated as follows:*

PRODUCTS OF COMBUSTION FROM 200 GRAMS OF THE EXPLOSIVE

	Grams.
Solid	79.7
Liquid (water)	14.5
Gaseous	88.4

Gaseous Products of Combustion

	Per cent. by volume.
Carbon dioxide	51.4
Carbon monoxide	5.0
Hydrogen	2.2
Methane	.3
Nitrogen	41.1
	100.0

Solid Products of Combustion

	Per cent.
Soluble (sodium carbonate)	79 43
Insoluble (calcium carbonate, trace of unburned carbonaceous matter, and carbonates and oxides of copper, iron, and tin)	20.57
	100.00

GASEOUS PRODUCTS OF COMBUSTION FROM 200 GRAMS OF THE EXPLOSIVE AND 12.4 GRAMS OF PAPER WRAPPER.

	Per cent.
Carbon dioxide	27.3
Carbon monoxide	26.9
Hydrogen	18.0
Methane	.4
Nitrogen	27.4
	100.0

Guncotton

If cotton is treated with nitric acid in a manner corresponding to the treatment given the glycerin, there results a substance, guncotton, or nitrocellulose, which is highly explosive. The chemical process is essentially a replacement of the hydrogen in the cotton by nitrogen and oxygen, this providing the oxygen necessary for burning the substance with explosive rapidity. Another high explosive, similar to guncotton in its composition and manufacture, is nitrostarch, made by nitrating starch.

Blasting Gelatine

A solution of guncotton in nitroglycerin makes a gelatinous substance, known as blasting gelatine, which is an extremely quick and powerful explosive, inasmuch as the carbon that would be left after explosion of the guncotton alone is consumed by the oxygen that would be left by the explosion of the nitroglycerin alone. The strength of blasting gelatine is rated at 100 per cent. The mixture of blasting gelatine with an absorbent dope is known as gelatine dynamite. Either form is considered to be especially suited to blasting under water.

Dynamite and other nitroglycerin mixtures must be thawed when frozen, because in the frozen condition, they are less susceptible to detonation, but more susceptible to ignition by friction. By the addition of certain chemicals to a nitroglycerin mixture, the freezing point may be greatly reduced, and thawing rendered unnecessary. There are many such low freezing explosives on the market, but no claim is made for them that they will not freeze at any temperature.

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*Bulletin 15, U. S. Bureau of Mines, page 172.

Fulminates

One subdivision of the high explosives class, known as fulminates, is important on account of their application in igniting other explosives. They are prepared by first treating certain metals with nitric acid, and then the resultant solution with alcohol. This type of explosive is extremely sensitive to heat or shock. The metal most frequently used as the basis of a fulminate is mercury. The mercury fulminate is especially convenient for communicating to charges of dynamite or other high explosive the shock necessary for ignition.

Comparison of High and Low Explosives in Coal Mining

The results of firing high and low explosives are very different. A low explosive like guncotton burns at the rate of about one foot per second, while for dynamite the corresponding figure is about 16,000 feet per second. The slower combustion allows the gaseous products to accumulate gradually, and therefore a low explosive is adapted to propulsion, as in a cannon. The rapid combustion of a high explosive produces the gases so suddenly, as well as in large volume, that the only outlet is through bursting the confining walls. The wave of explosion in the latter case is less restricted in the direction of its propagation, and so is more adapted to shattering than to propulsion.

Black powder was for many years the only explosive used for breaking coal, the chief advantage lying in its avoidance of excessive shattering, which would be very objectionable for most coals. An incidental advantage is the tendency of black powder to throw coal forward from the face, thus assisting in the loading.

On the other hand, some qualities of the high explosive would be more favorable to its use in coal mining than the low. The combustion of black powder produces gases, of whose volume 40 per cent. or more is itself combustible, chiefly carbon monoxide. In the confined spaces of underground workings, the liability of igniting these gases is great, either by the miner's lamp, or by a later blast. Pure nitroglycerin generates in its combustion no carbon monoxide or other combustible gases, although a relatively small quantity of such gases is generated from dynamite and other nitroglycerin mixtures. The combustible gases are frequently poisonous as well, and this is especially true of carbon monoxide. But from the standpoint of coal mining, the most important difference between high and low explosives lies in the character of the flame produced by each. The Bureau of Mines estimates for a typical black powder, a flame 50.21 inches high and lasting 1539 milliseconds, while for a standard dynamite the flame was found to be 24.63 inches high and to last for only 0.350 millisecond. The height of the black powder flame is thus seen to be about twice that of the dynamite flame, and its duration is seen to be about 4400 times that of the dynamite flame.

Permissible Explosives

It is evident that an explosive combining the breaking and propelling qualities of black powder with the relatively low and short flame of dynamite would be nearly ideal for coal mining. Such a material would avoid the shattering effect of dynamite and the undesirable flame characteristics of black powder. The first definite efforts to find an explosive meeting these requirements seem to have been made about 1873 in England.

Thus, the water cartridge was developed. It was essentially a case filled with water, enclosing the charge of high explosive. In use, the water distributed over a large area the pressure generated by the explosive, instead of concentrating it and shattering the coal. It also cooled the flame materially. Some experiments with a view to finding a flameless explosive were made about the same time, and several mixtures were proposed that reduced the flame, but none succeeded in eliminating it. These improvements were recognized several years later by the Coal Mines Regulation Act of Great Britain, wherein it is provided that in gaseous working places, "the explosive employed in firing the shot is so used with water or other contrivance as to prevent it from inflaming gas, or is of such a nature that it cannot inflame gas." The water cartridge, while good in principle, proved expensive and somewhat difficult to manipulate underground. The idea of the flameless explosive was the one that promised most. Experiments followed in some of the European countries, especially in government laboratories, and a number of explosives designed for safety in the presence of gas were tested with satisfactory results. In Great Britain, a class known as the permitted explosives was established, and only the mixtures listed were allowed in gaseous mines.

In the United States, little was accomplished in this direction, except by the manufacturers. The federal government, having no jurisdiction over the mines in the states, could not enforce the use of a selected list, as could the European governments, It was not until after the series of disastrous coal mine explosions in 1907 and 1908 that the Bureau of Mines was established. A large part of its work has been directed toward safety in the use of explosives, and it has issued numerous publications of value to those interested.

The Bureau of Mines has made tests that determine the quality, strength and safety for coal mine use of samples of explosives submitted by manufacturers. Those materials that pass all the tests satisfactorily are placed on the list of Permissible Explosives. The list, as now constituted, embraces four classes.

Class 1, the Ammonium Nitrate Explosives, includes those using ammonium nitrate (NH_4NO_3) as the oxidizer, the chief advantage of which is that water is a large product of the explosion. Thus the temperature is materially reduced. Class 1 includes two subclasses. In subclass a are included the explosives having explosive sensitizers, and in subclass **b**, those with nonexplosive sensitizers.

Class 2, the Hydrated Explosives, includes those containing water of crystallization, the purpose of the latter being to reduce the flame temperature.

Class 3, the Organic Nitrate Explosives, includes those containing nitrostarch.

Class 4, the Nitroglycerin Explosives, includes those containing nitroglycerin. These might be placed with the organic nitrate class, but the nitroglycerin explosives are so important and so different from other organic nitrate explosives that the separate classification is appropriate. The flame temperature is usually reduced by the presence of water in the mixture. To remove the objections to nitroglycerin on account of its shattering effect on the coal, substances are added that tend to neutralize these effects.

Classes 1a and 4 are the most numerous, the others being represented as yet by a very small number relatively.

The tests made on each mixture submitted are designated as follows: physical examination, unit deflective charge, gas and dust gallery, rate of detonation, flame test, explosion by influence test, impact test, pressure gauge test, calorimeter, compression of small lead blocks and expansion of bore hole of Trauzl lead blocks.

The Physical Examination embraces dimensions, weight and specific gravity of cartridge, together with color and consistency of the explosive material.

The Unit Deflective Charge is the quantity of the explosive by weight that is equivalent in strength to one half pound (227 grams) of standard dynamite. The quantity is determined by firing a charge in a cannon and noting the deflection of a ballistic pendulum, Fig. 3. This deflection is compared with that from firing the half pound of standard dynamite under similar conditions. Unit deflective charges of permissible explosives are listed in Table I.

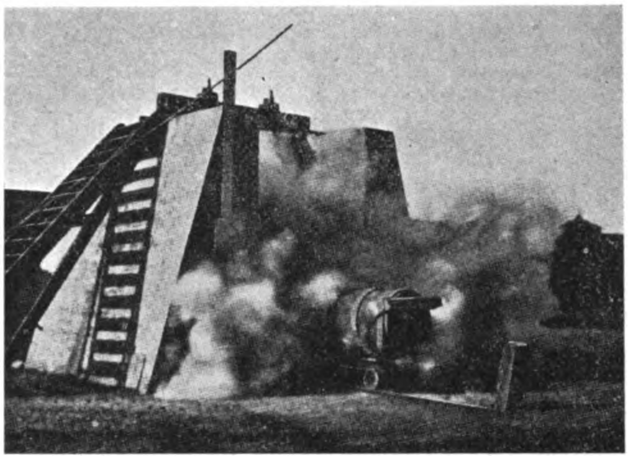

Fig. 3—Ballistic Pendulum.

The Gas and Dust Gallery is a steel cylinder open at one end, 100 feet long and 6 feet 4 inches in diameter, intended to duplicate as far as possible a coal mine entry. At the closed end, Fig. 4, the unit deflective charge is fired a number of times from a hole, similar to the drill hole used in a mine, into certain definite mixtures of explosive gas and air, and into coal dust distributed through the gallery according to certain standards. In order to pass this test, the explosive must not ignite the gas or dust in any of the trials. Black blasting powder has never failed to produce ignition in any of these tests.

The Rate of Detonation is the velocity at which the explosion progresses through the charge. As the shattering effect is about proportionate to this velocity, a measure of the shattering effect is thereby obtained. An electric recording instrument is used to measure the rate of detonation. The rates for permissible explosives in no case equal the rate for standard dynamite.

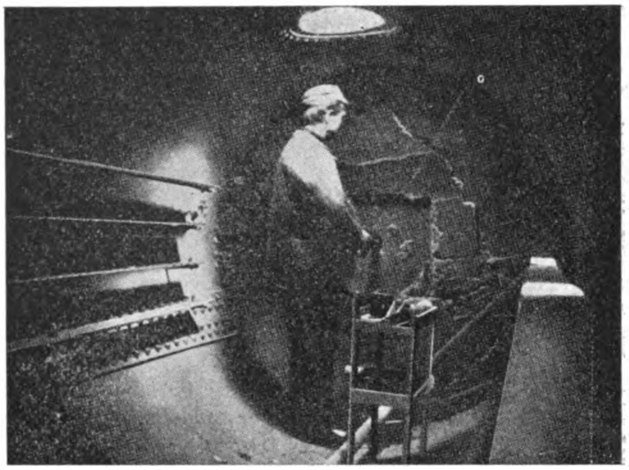

Fig. 4—Loading Gun in Gas and Dust Gallery.

The Flame Test is one of the most important, inasmuch as its purpose is to measure the height and duration of the flame. The process is one of photographing the flame on a film moving at a known speed. The flames of permissible explosives approximate in height and duration that of standard dynamite.

The Explosion by Influence Test estimates the sensitiveness of an explosive to the wave produced by an ignition of a mass of the same material in the vicinity. Trials are made with sets of two cartridges at different distances, and the minimum distance at which no explosion occurs is recorded.

The Impact Test is made by dropping a steel hammer from different heights upon a charge of explosive which rests upon a steel anvil. The greatest fall producing no explosion is the record sought.

The Pressure Gauge Test determines the pressure per unit of area exerted by the firing of a charge in a space just large enough to contain the charge.

The Calorimeter Test determines the heat generated by ignition of a certain quantity of the explosive. The heat is transmitted to a known quantity of water, and the increase in the temperature of the water is measured, from which the number of calories may be computed.

The Test for Compression of Small Lead Blocks is made by firing a charge of explosive in contact with lead cylinders 2½ inches high and 1½ inches in diameter. The amount of compression is found by measuring the height of the block after the test and comparing with the original height.

The Test for Expansion of Bore Hole of Trauzl Lead Blocks is made with blocks 7.87 inches high and 7.87 inches in diameter, into which a hole has been bored a little over half the length. The charge is placed in the bottom of the hole and fired. The volume of the bore hole before and after the explosion is measured by means of water, the difference between the volumes being the amount of expansion.

A list of the Permissible Explosives together with the name of manufacturer of each, its classification and other data, is given in Table I. The list is subject to revision by the addition of explosives that may pass future tests. It may also be revised by the withdrawal of any explosive on the part of the manufacturer, or by its removal on the part of the Bureau of Mines, in case the quality is not maintained, or in case more rigid tests are prescribed in future.

The approval of these explosives is intended to cover only those cases in which the explosives are used in accordance with specified conditions, namely, that it is similar to the sample tested, that detonators of a certain minimum strength, generally No. 6, are used to fire the charge, that the explosive is completely thawed and that the quantity in one shot does not exceed 1½ pounds.

The permissibles are marketed in a form similar to that of the high explosives. The paper cartridges are usually 1¼ inches or 1½ inches in diameter and 8 inches long, but other sizes are on the market. Either 25 pounds or 50 pounds are packed in a wooden case.

The use of black blasting powder in coal mines is decreasing, while that of permissible explosives is increasing rapidly. Although few of the states require the use of permissibles in gaseous coal mines, still the general tendency throughout the country, both officially and unofficially, is to encourage their use under such conditions, and in some instances, under all coal mining conditions.

Some of the permissible mixtures are adapted only to ordinary temperatures; others may be used at lower temperatures and are termed low freezing. Some are adapted to use in wet drill holes; others should be used in dry holes only. Other points of difference are the strength, speed, shattering effect and amount of fumes generated. For each set of conditions under which the explosive is to be used, one or more may be selected as best suited to the given conditions, while others may be wholly unsatisfactory for the same conditions. The experience of the manufacturer and the tests outlined above are valuable guides to selection of the proper permissible out of the great variety offered.

TABLE I.*

Permissible explosives tested prior to April 30, 1917

Brand.	Class designation.	When used with detonators, preferably electric detonators of not less efficiency than—	Unit deflective charge.	Rate of detonation in 1¼ by 8 inch cartridge.		Manufacturer.
			Grams.	Feet per second.	Meters per second.	
Aetna coal powder A	Class 4	No. 6	277	12,620	3,848	Aetna Explosives Co. (Inc.), New York, N. Y.
Aetna coal powder AA	Class 1a	do	241	7,880	2,403	Do.
Aetna coal powder B	Class 4	do	301	9,870	3,008	Do.
Aetna coal powder C	do	do	344	7,010	2,138	Do.
Aetna coal powder No. 2	Class 1a	do	212	9,280	2,830	Do.
Bental coal powder No. 2	do	No. 7	276	4,750	1,447	Hercules Powder Co., Wilmington, Del.
Bental coal powder No. 2-X	do	No. 6	280	7,980	2,432	Do.
Big Red No. 1	do	do	240	7,250	2,209	The Equitable Powder Manufacturing Co. and the Egyptian Powder Co., East Alton, Ill.
Big Red No. 2	do	do	255	10,850	3,309	Do.
Big Red No. 4-L. F	do	do	254	10,290	3,138	Do.
Big Red No. 5	do	do	260	7,490	2,284	Do.
Big Red No. 7	do	do	227	10,000	3,050	Do.
Big Red No. 6-L. F	do	do	242	7,480	2,280	Do.
Bituminite No. 1	Class 4	do	318	12,800	3,901	Aetna Explosives Co. (Inc.), New York, N. Y.
Bituminite No. 3	do	do	294	9,330	2,843	Do.
Bituminite No. 4	do	do	301	7,540	2,298	Do.
Bituminite No. 5	Class 1a	do	231	9,120	2,782	Do.
Bituminite No. 8-L. F	Class 4	do	303	9,300	2,834	Do.
Black Diamond No. 2-A	do	do	281	12,600	3,842	Illinois Powder Manufacturing Co., St. Louis, Mo.
Black Diamond No. 3-A	do	do	294	11,160	3,402	Do.
Black Diamond No. 5	Class 1a	do	288	6,020	1,835	Do.
Black Diamond No. 6-L. F	Class 4	do	306	9,630	2,935	Do.
Black Diamond No. 7	Class 1a	do	214	10,730	3,270	Do.
Black Diamond No. 8	Class 4	do	295	8,730	2,663	Do.
Cameron mine powder No. 1-A	Class 1a	No. 6	227	10,950	3,339	Cameron Powder Manufacturing Co., Emporium, Pa.
Cameron mine powder No. 2-A	do	do	230	†10,520	3,206	Do.
Cameron mine " No. 2-A. L. F	do	do	233	10,950	3,338	Do.
Cameron mine powder No. 3-A	Class 4	do	296	10,930	3,333	Do.
Cameron mine powder No. 5-A	do	do	299	8,900	2,712	Do.
Carbonite No. 1	do	do	259	10,950	3,338	E. I. du Pont de Nemours & Co., Wilmington, Del.
Carbonite No. 2	do	do	302	11,380	3,470	Do.
Carbonite No. 2-L. F	do	do	305	7,830	2,387	Do.
Carbonite No. 3	do	do	325	8,710	2,656	Do.
Carbonite No. 4	do	do	327	7,670	2,339	Do.
Carbonite No. 5	do	do	304	10,140	3,092	Do.
Carbonite No. 6	do	do	345	7,490	2,285	Do.

*Prepared by U. S. Bureau of Mines.

†1½-inch cartridges used.

Permissible explosives tested prior to April 30, 1917—Continued.

Brand.	Class designation.	When used with detonators, preferably electric detonators of not less efficiency than—	Unit deflective charge.	Rate of detonation in 1¼ by 8 inch cartridge.		Manufacturer.
			Grams.	Feet per second.	Meters per second.	
Coalite X	Class 1a	No. 6	226	9,000	2,745	Atlas Powder Co., Wilmington, Del.
Coalite Y	do	do	235	10,300	3,141	Do.
Coalite No. 1	Class 4	do	296	7,930	2,418	Do.
Coalite No. 2-D	do	do	310	8,430	2,571	Do.
Coalite No. 2-D. L	do	do	271	7,340	2,237	Do.
Coalite No. 2-M. L. F	do	do	301	9,220	2,811	Do.
Coalite No. 3-XC	Class 1a	do	250	8,320	2,536	Do.
Coalite No. 3-Y. C	do	do	250	9,670	2,949	Do.
Coal special No. 1	Class 4	do	288	11,800	3,598	Aetna Explosives Co. (Inc.), New York, N. Y.
Coal special No. 1-A	do	do	276	9,370	2,857	Do.
Coal special No. 1-L. F	do	do	277	8,280	2,524	Do.
Coal special No. 2	do	do	304	10,240	3,123	Do.
Coal special No. 2-W	do	do	277	11,590	3,534	Do.
Coal special No. 3-C	do	do	288	9,760	2,977	Do.
Collier powder B, N. F	Class 1a	do	224	10,950	3,338	Do.
Collier powder KN	do	do	222	11,610	3,539	Do.
Collier powder No. X	do	do	273	7,820	2,384	Do.
Collier powder X, L. F	do	do	252	9,990	3,047	Do.
Collier powder No. 2	Class 4	do	300	8,870	2,704	Do.
Collier powder No. 5	Class 1a	do	240	8,280	2,524	Do.
Collier powder No. 5-L. F	do	do	232	9,370	2,858	Do.
Collier powder No. 5, special	Class 1a	No. 6	236	8,330	2,541	Aetna Explosives Co. (Inc.), New York, N. Y.
Collier powder No. 6-L. F	Class 4	do	317	9,660	2,944	Do.
Collier No. 9	Class 1a	do	283	6,690	2,040	Do.
Collier powder No. 11	do	do	217	11,680	3,561	Do.
Collier powder No. 11-L. F	do	do	226	10,850	3,307	Do.
Cronite No. 1	do	do	233	10,490	3,198	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Cronite No. 5	do	No. 7	249	8,090	2,466	Do.
du Pont Lump Coal Powder No. 1	Class 4	No. 6	382	5,200	1,586	E. I. du Pont de Nemours & Co., Wilmington, Del.
du Pont Permissible No. 1	Class 1a	do	278	9,610	2,930	Do.
Eureka No. 2	Class 2	do	311	10,720	3,269	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Franklinite No. 1	Class 4	do	288	9,760	2,977	Aetna Explosives Co. (Inc.) New York, N. Y.
Franklinite No. 2	do	do	300	8,870	2,704	Do.
Franklinite No. 3	do	do	304	10,240	3,123	Do.
Franklinite No. 4	do	do	344	7,010	2,138	Do.
Franklinite No. 5	Class 1a	do	232	9,370	2,858	Do.
Franklinite No. 6	do	do	252	9,990	3,047	Do.
Fuel-ite No. 3	Class 1a	do	215	8,590	2,620	Burton Powder Co., Pittsburgh, Pa.
Fuel-ite	do	do	229	10,810	3,296	Do.
Giant coal-mine powder No. 5	do	do	228	10,230	3,118	Giant Powder Co (Con.), Giant, Cal.
Guardian No. 2	Class 1a	No. 6	245	8,980	2,738	Hercules Powder Co., Wilmington, Del.
Guardian No. 2-X	do	do	245	7,990	2,437	Do.
Guardian No. 3	do	do	272	7,660	2,336	Do.
Guardian No. 3-X	do	do	252	8,470	2,582	Do.
Hecla No. 2	Class 1a	No. 7	253	13,990	4,264	E. I. du Pont de Nemours & Co., Wilmington, Del.
Hygrade coal powder No. 2	Class 4	No. 6	329	8,450	2,576	Hygrade Powder Co., Philadelphia, Pa.
Kanite A	Class 1b	No. 8	255	*10,730	3,270	W. H. Blumenstein Chemical Works, Pottsville, Pa.
Little Red No. 2	Class 4	No. 6	321	9,300	2,836	The Equitable Powder Manufacturing Co. and the Egyptian Powder Co., East Alton, Ill.
Little Red No. 3	Class 4	No. 6	325	7,940	2,421	The Equitable Powder Manufacturing Co. and the Egyptian Powder Co., East Alton, Ill.
Little Red No. 4	do	do	349	8,100	2,469	Do.
Little Red No. 5-L. F	do	do	300	11,110	3,387	Do.
Little Red No. 6-L. F	do	do	333	7,650	2,331	Do.
Lomite No. 1	Class 2	do	300	13,940	4,250	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Lowinite No. 2-B	Class 1a	do	258	9,740	2,971	Lowinite Explosives Manufacturing Co., Pittsburgh, Pa.
Meteor AXXO	Class 2	do	434	8,410	2,563	E. I. du Pont de Nemours & Co., Wilmington, Del.
Mine-ite A	Class 4	do	296	11,290	3,443	Burton Powder Co., Pittsburgh, Pa.

Permissible explosives tested prior to April 30, 1917—Continued.

Brand.	Class designation.	When used with detonators, preferably electric detonators of not less efficiency than—	Unit deflective charge.	Rate of detonation in 1¼ by 8 inch cartridge.		Manufacturer.
			Grams.	Feet per second.	Meters per second.	
Mine-ite A-2	Class 4	No. 6	319	10,670	3,252	Burton Powder Co, Pittsburgh, Pa.
Mine-ite B	...do	...do	340	9,540	2,908	Do.
Mine-ite No. 5-D	Class 1a	...do	241	8,720	2,658	Do.
Mine-ite No. 6-D	...do	...do	224	8,090	2,467	Do.
Miners Friend No. 1	...do	...do	233	11,580	3,529	Atlas Powder Co., Wilmington Del., and Giant Powder Co. (Con.), Giant, Cal.
Miners Friend No. 2	...do	...do	260	10,330	3,149	Do.
Miners Friend No. 3	...do	...do	252	8,030	2,449	Do.
Miners Friend No. 4	...do	...do	261	9,980	3,044	Do.
Miners Friend No. 5	Class 1a	...do	250	8,570	2,614	Do.
Miners Friend No. 6	...do	...do	234	10,900	3,324	Do.
Miners Friend No. 7	...do	...do	253	8,950	2,729	Do.
Miners Friend No. 8-L. F.	Class 4	...do	421	4,650	1,417	Do.
Monobel No. 1	...do	...do	216	11,700	3,568	E. I. du Pont de Nemours & Co., Wilmington, Del.
Monobel No. 2	...do	...do	239	9,870	3,009	Do.
Monobel No. 3	...do	...do	243	7,260	2,212	Do.
Monobel No. 4	...do	...do	248	8,980	2,738	Do.
Monobel No. 5	...do	...do	267	6,760	2,061	Do.
Monobel No. 6	...do	...do	218	10,380	3,165	Do.
Monobel No. 7	...do	...do	211	10,050	3,065	Do.
Nitro low-flame No. 1	Class 4	...do	303	13,380	4,079	Nitro Powder Co., Kingston, N. Y.
Nitro low flame No. 2	...do	...do	298	14,560	4,439	Do.
Red H No. 1	Class 1a	...do	216	11,700	3,568	Hercules Powder Co., Wilmington, Del.
Red H No. 2	...do	...do	239	9,870	3,009	Do.
Red H No. 3	...do	...do	243	7,260	2,212	Do.
Red H No. 4	...do	...do	248	8,980	2,738	Do.
Red H No. 5	...do	...do	267	6,760	2,061	Do.
Red H No. 6	...do	...do	218	10,380	3,165	Do.
Red H No. 7	...do	...do	211	10,050	3,065	Do.
Red H No. 8	...do	...do	278	7,590	2,315	Do.
Trojan coal powder H	Class 3a	...do	394	9,420	2,872	Pennsylvania Trojan Powder Co., Allentown, Pa.
Trojan coal powder I	...do	...do	410	9,620	2,934	Do.
Trojan coal powder J	...do	...do	360	10,590	3,230	Do.
Trojan coal powder K	Class 3b	...do	314	10,380	3,164	Do.
Trojan coal powder L	...do	...do	275	10,560	3,221	Do.
Trojan granular coal powder No. 1	Class 3a	...do	265	*7,920	2,416	Do.
Tunnelite AA	Class 1a	...do	253	7,690	2,346	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Tunnelite B	...do	...do	249	9,990	3,047	Do.
Tunnelite C	...do	...do	255	10,060	3,068	Do.
Tunnelite No. 3	Class 4	...do	291	10,110	3,083	Do.
Tunnelite No. 4	...do	...do	309	10,620	3,238	Do.
Tunnelite No. 5	...do	...do	328	8,400	2,562	Do.
Tunnelite No. 6	...do	...do	305	9,670	2,947	Do.
Tunnelite No. 6-L. F.	...do	...do	301	9,620	2,933	Do.
Tunnelite No. 7	...do	...do	311	8,720	2,659	Do.
Tunnelite No. 8	...do	...do	324	8,020	2,446	Do.
Tunnelite No. 8-L. F.	...do	...do	322	8,720	2,658	Do.
Vigorite No. 1	...do	...do	259	10,950	3,338	Atlas Powder Co., Wilmington, Del., and Giant Powder Co. (Con.), Giant, Cal.
Vigorite No. 2	...do	...do	298	10,920	3,330	Do.
Vigorite No. 3	...do	...do	320	8,140	2,483	Do.
Vigorite No. 4	...do	...do	341	7,480	2,281	Do.
Vigorite No. 5	...do	...do	308	10,830	3,303	Do.
Vigorite No. 6	...do	...do	345	7,490	2,285	Do.
Xpdite No. 1	...do	...do	259	10,950	3,338	Hercules Powder Co., Wilmington, Del.
Xpdite No. 2	...do	...do	302	11,380	3,470	Do.
Xpdite No. 3	...do	...do	325	8,710	2,656	Do.
Xpdite No. 4	...do	...do	327	7,670	2,339	Do.
Xpdite No. 5	...do	...do	304	10,140	3,092	Do.
Xpdite No. 6	...do	...do	345	7,490	2,285	Do.

*1⅞-inch cartridges used.

SUBSTITUTES FOR EXPLOSIVES

In gaseous mines, the problem of breaking the coal is sometimes solved otherwise than by the use of permissibles. Several substitutes have been proposed and used, and these may have their application also in the few instances where it is impractical or inadvisable to use any explosives. These expedients have been more favored in Europe than in America.

The simplest substitute is the wedge, used for prying down the coal after it has been undercut. An improvement is the plug and feather, consisting of two tapered pieces to be inserted into the hole and a wedge-shaped piece to be driven between them. A further modification is the use of a second pair of tapered pieces, instead of the wedge-shaped piece, followed if necessary by a third pair. Rollers between the pieces are sometimes used to reduce the friction. In the longwall system of mining, wedges have special application, because the coal is broken to some extent by the weight of the overburden, and the wedges may be used to complete the breaking. An objection to the use of wedges lies in the labor necessary, whereas in recent times, the tendency has been to reduce labor. It appears that the method is better adapted to hard than to soft coal, because the soft coal is often only crushed in the immediate vicinity of the wedge, and is not actually broken down.

The lime cartridge uses the expansive power of wetted lime to break down the coal. Lime in dry powder form is pressed into cylindrical sticks approximating in size the dynamite cartridges. These sticks, or cartridges, are placed in the hole prepared for them, and when water is pumped in, the lime expands in slaking, breaking the coal. The lime cartridge is said to be economical in the case of coals to which it is adapted, but the process requires some time, and the miners complain of unavoidable contact with a small residue of unslaked lime, which slakes on their hands. The temperature produced by a lime cartridge is high, but not as high as the ignition point of marsh gas.

The hydraulic cartridge uses hydraulic pressure for the purpose of breaking the coal. After the holes are drilled at the proper intervals along the face near the roof, the cartridge (a hollow steel cylinder) is inserted. At the inner end of the cartridge are eight pistons, while at the outer end are the pump and reservoir. Only 1½ pints of water are required for the process, and this may be used again. The pressure exerted on the coal with an average sized cartridge is about three tons per square inch. The hydraulic cartridge has been very successful and economical in certain districts in England, and avoids most of the objections to the other substitutes, at the same time breaking the coal in large lumps.

USE OF EXPLOSIVES

Location of Drill Holes

In placing drill holes for blasting, it is desirable to take advantage of the position of free, or exposed faces. It is also desirable to have as many free faces as possible, because for a larger number, the work required of the explosive will be less, and a smaller quantity or a less powerful explosive may be used. There is always one free face, that on which the drill holes are placed, and others may be obtained by cutting or by blasting. The direction and length of the hole must be such that the line of least resistance is shorter than the hole. The line of least resistance is defined as the shortest line from the charge to a free face. Upon this line, either the material will be broken, or the greatest effect of the blast will be felt. If it coincides with the drill hole, the resistance in the direction of the hole is likely to be the least, and no useful effect will then be obtained. To secure the most economical results, the charge should be placed behind the center of gravity of the mass to be loosened.

In case the material has bedding planes or cleavages, as is true of most coals, Fig. 5, advantage should be taken of these in placing the shots. The presence of a bedding plane or cleavage reduces the work required to break the coal in that direction, and consequently the position of the shot may be shifted, with a view to balancing the work in all directions.

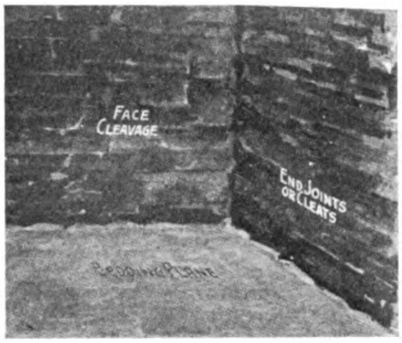

Fig. 5—Cleavages and Bedding Plane of a Coal Seam.

It is customary in coal mining to make one or more cuts across a face, either horizontal or vertical, or both. A horizontal cut is sometimes at the top or middle, but usually at the bottom, and is then called an undercut. A vertical cut, which is termed a shearing cut, may be at one side or in the middle. The number of holes used in any working place in a coal mine depends upon the width of the place and upon the character of the coal. Assume the seam to be 6 feet thick, and the place to be not over 25 feet wide. An undercut is about 4 feet deep when made by hand with a pick, and 5 feet to 10 feet deep when made by machine. The standard practice would be to use three holes, one at each side near the roof and one about 4 feet above the floor, the latter so pointed as to have its inner end near the middle. A rule generally followed makes the depth of the hole less than the depth of the cut. Fig. 6 shows front and side views of the coal face with the holes in position. The middle hole being fired first, would have two free faces on which to work, while the side shots, fired later, either separately or together, would have three. The central shot, often called the buster shot, or breaking-in shot, would break roughly a triangular section of face with apex at the drill hole and base on the upper edge of the undercut, and coal in the vicinity of this break, particularly above it, would be loosened, so that it might be picked down easily. The other holes would break their respective halves of the face remaining. In case the undercut is relatively narrow, such as would be made by a chain cutter, about 6 inches in thickness, there is a tendency for the coal after being blasted to settle on the base of the undercut

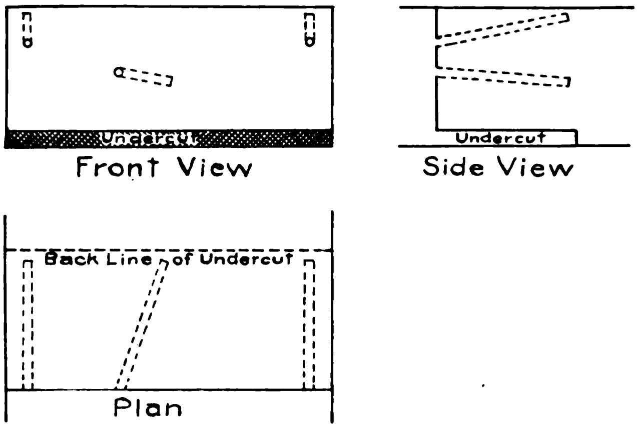

Fig. 6—Location of Drill Holes for Undercut.

and not fall forward from the face. This condition makes the loading more difficult, and is avoided by removing a strip of coal not usually over 2 feet high from the front of the portion immediately above the undercut. This process is known as snubbing, and the coal broken in the process is known by the same name. The snubbing may be accomplished by hand work with pick, or by light shots placed at the top of the strip to be broken.

For narrow places, such as entries or extra narrow rooms, two shots are generally used, aside from such snubbing shots as may be necessary. One of these is placed near one of the ribs, and serves as the buster shot. The other at the opposite rib completes the breaking. It is rarely possible to break a complete face with less than two shots. More than three may sometimes be required, when the system of mining involves extra wide rooms.

A typical arrangement of holes to blast coal after a shear cut is shown in Fig. 7. The coal may be both sheared and undercut, if difficult to blast with a reasonable quantity of explosive.

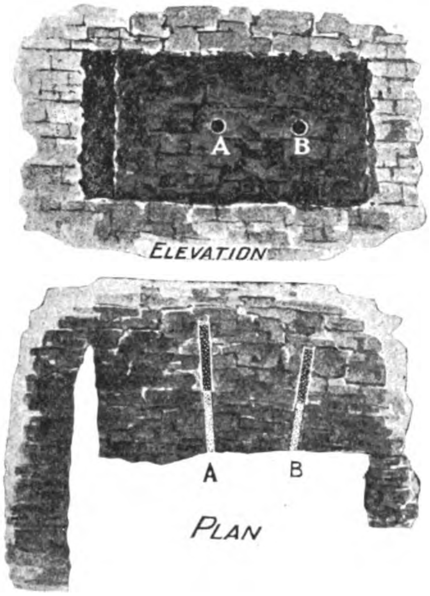

Fig. 7—Location of Drill Holes for Shear Cut.

In addition to the practice of blasting after undercutting, or other forms of cutting, there is that of blasting without cutting or shooting off the solid. According to the United States Geologocial Survey, about 15.9 per cent. of the bituminous coal mined in the United States in 1915 was shot off the solid, but the distribution is not uniform. In general, the eastern bituminous districts follow the practice very little, but the central states produce large percentages of their coal in this way. In the anthracite fields of Pennsylvania, shooting off the solid is the custom, but cutting machines are gradually being introduced. The placing of the hole is illustrated in Fig. 8. It is drilled at a small angle to the solid face, rarely over 35°. It is considered necessary for safety that a perpendicular from the inner end of a drill hole intersect the free face, and that the length of the perpendicular be not over two-thirds the thickness of the seam. If greater, the resistance would exceed that on the line of the drill hole, and produce a blown-out shot. The length of hole is expected not to be greater than the seam thickness. The dimensions shown in Fig. 8 apply to a seam 6 feet thick. A hole so placed is called a gripping hole, to distinguish it from those drilled at larger angles with the face. On account of the resistance offered, particularly when the material is without well-defined bedding planes, a slow explosive does the work best, and black blasting powder is commonly used. A series of holes, similar to the one illustrated, is drilled, charged and fired, beginning at the middle and progressing toward the sides. The shots following the first are easier, since two free faces are usually available after the first blast.

Fig. 8—Location of Drill Holes for Shooting off the Solid.

Solid shooting is practiced chiefly because of the saving in time and labor that would be required for the cut. There are objections to it, however. The danger of gas or dust explosion is present in most mines, and from what has already been stated regarding black blasting powder, it will be clear that the danger is increased by solid shooting. An obejction from another standpoint lies in the fact that the coal broken is in a finer condition, and in many cases is not as readily marketable on that account.

The laws tend toward prohibition of solid shooting, but in the important coal mining states, some discretion is left to the inspector to authorize it in the cases where cutting is impractical.

When permissible explosives are used, the drill holes are located in essentially the same position relative to the face as when black blasting powder is the explosive. It is desirable, however, to incline the drill hole sufficiently to reach the roof, in order that the coal may be broken promptly from the top of the seam, and the shattering effect prevented, which would occur with permissibles, if the resistance to breaking is too great.

Drilling of Holes

The holes for blasting in coal are usually drilled with a rotary drill or auger. There are three general types, breast, grip and power drills. The breast type is revolved by hand, and braced against the body of the driller. It is widely used in bituminous mines. The grip type is held in place by a metal bar, or grip, wedged into a small and shallow hole, previously drilled in the coal with a smaller auger. This type is favored in the anthracite mines, because the grip overcomes to a large extent the difficulty of cutting the hard coal. The power drill is supplied with a motor, either compressed air or electric, and has its application chiefly in anthracite coal.

Drill holes should be as straight as possible. A precaution sometimes taken to insure their being no longer than the depth of cut is the making of the drill a little shorter than the normal depth of cut. The hole should be slightly larger in diameter than the cartridge used, so that the latter may be pressed into place at the inside of the hole. In no event should the hole be smaller than the cartridge, because a large risk of ignition by sparks or friction is incurred when forcing the cartridge in.

Charging

Since black blasting powder is most conveniently shipped and delivered in bulk, it is necessary to prepare the cartridges immediately prior to their use. It is customary for the miner to form the cartridge about a wooden stick of proper dimensions, using a strong paper designed for the purpose. To avoid carrying a stick solely for making cartridges, a pick handle is often used. A method of later introduction is a paper bag of the proper size and shape, which saves time and insures uniformity. The maximum practical length for separate cartridges is about 18 inches, but several may be used, if more powder is required in a drill hole.

The greatest efficiency from an explosive is obtained when the space in which the gases are generated is as small as possible, the pressure thereby being made a maximum. This condition is attained when the charge fills its cavity completely. Therefore, the cartridges are pressed firmly into the space. Sometimes it is necessary or advisable to slit the cartridge, so that the contents are more free to fill the space. There is an apparent exception to be noted: if the shattering effect of the explosive happens to be too great for the coal, an air space is left around the cartridges or in front of them, in order to provide a cushion, which distributes the force of the explosion, and thereby produces more lump with less fine coal.

The quantity of powder to be used in a hole is sometimes estimated by formulas, but these are unreliable, since local conditions vary widely. Experience appears to be the best guide in this particular. An overcharged hole may shatter the coal, loosen the roof and project flame into the mine. An undercharged hole may fail to do the work expected of it, and may be the cause of a blown-out shot, by which the tamping is blown from the hole, followed by a long flame. Gas and dust explosions are believed to have originated in many cases from this cause.

Means of Firing

The simplest means of firing is a squib, a thin paper tube, about 6 inches long, one end of which contains a core of meal powder and the other a slow match. After the cartridges are in position, a copper, or copper tipped, needle a quarter of an inch in diameter is pushed into the outer end of the charge, as shown in Fig. 9. About the needle the clay tamping material is packed with a wooden bar. The needle is then withdrawn, leaving a passage of its own dimensions from the outside of the hole to the powder. Into this hole the squib is placed. After the match is lighted, Fig. 10, a brief interval elapses before the squib is projected forward like a rocket and its flame ignites the powder.

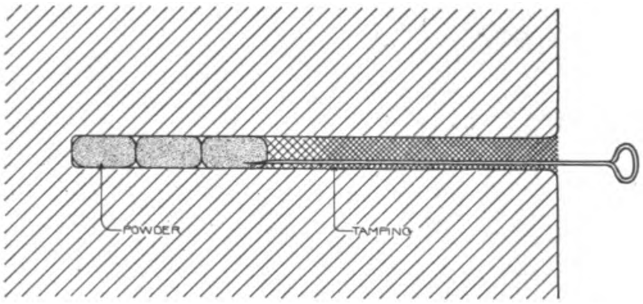

Fig. 9—Drill Hole, Showing Needle in Place.

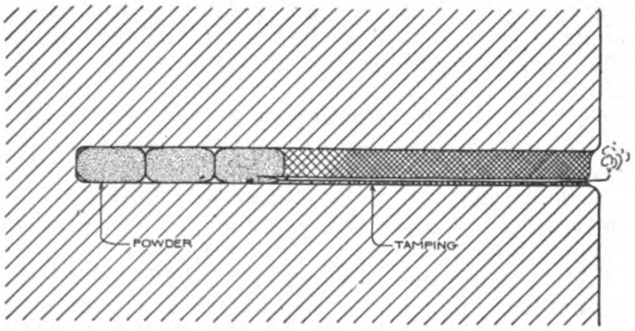

Fig. 10—Drill Hole, Showing Squib Lighted.

The squib has the advantage of cheapness, and usually of time saving, but is uncertain on account of possible caving of the needle hole. Another objection is the danger of igniting explosive gases that may be present.

To make the passage for the squib more substantial, a blasting barrel, Fig. 11, is sometimes used, which is a section of pipe of suitable length and diameter. The squib is used in the same manner as when the passage is formed by a needle. The blasting barrel is usually recovered after an explosion and used again.

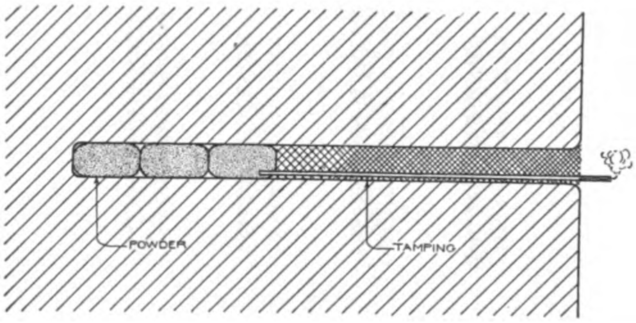

Fig. 11—Drill Hole, Showing Blasting Barrel in Place.

A second means of igniting a charge of powder is fuse, generally called safety fuse, Fig. 12, which is a train of fine powder enclosed in hemp or cotton, covered with one or more layers of tape for the purpose of waterproofing. When lighted at one end, flame travels along inside the tube to the other end, where, if placed within the charge, it ignites the powder. Fuse usually burns at the rate of 1½ to 2 feet per minute, and the rate is specified by the manufacturer. The blaster is thus enabled to estimate the length of fuse required to enable him to reach a safe place, and by cutting a fuse to proper length, may take more time than a squib would allow. The rate of burning cannot be guaranteed, however, as fuse may be subjected to injury that would interrupt the train of powder. It is advis-

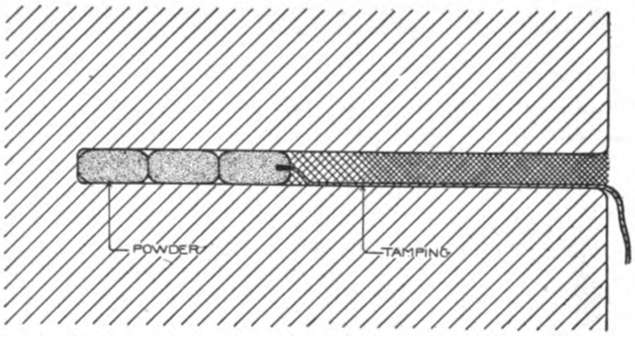

Fig. 12—Drill Hole, Showing Fuse in Place.

able to make tests of the fuse in use for rate of burning. Failure of a charge to explode may be only temporary, and the flame may be started again on its path after an interval. Many lives have been lost by returning prematurely to investigate a delayed ignition. Fuse is prepared for conditions varying from dry to submarine, the difference being mainly in the character of taping. The uncertainty of fuse and its tendency to flame are serious obejctions.

A third method of ignition involves the use of detonators. It may be applied to low explosives, but is most used in firing high explosives and permissibles, and is the only approved method of firing the latter. A detonator is distinguished from an electric detonator. The former is commonly called a blasting cap. A blasting cap (or detonator proper), as shown in Fig. 13, is a copper cylinder about a quarter of an inch in diameter and from 1¼ inches to 1⅞ inches long, filled for about one-third to one-half its length with mercury fulminate or a mixture of mercury fulminate with potassium chlorate. The sensitiveness and other qualities of these substances have already been described. The other end of the detonator is left open for inserting the end of a fuse, which, when lighted, conveys flame directly to the mercury fulminate or other composition. The ignition of this substance produces a shock that is ample to detonate completely the charge of high or permissible explosive. In the attachment of fuse to blasting cap, Fig. 14, it is desirable to have a tight fit, in order to maintain their relative position, but not so tight as to break the powder train inside the fuse. The best and safest means of attaching is a crimper designed for the purpose. The crimper is often combined with a fuse cutter in one tool.

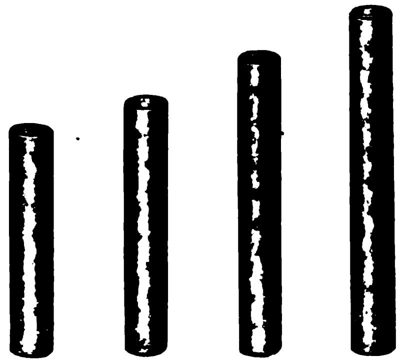

Fig. 13—Detonators.

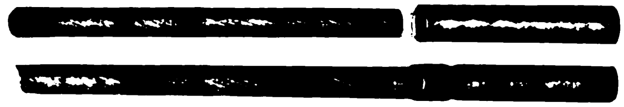

Fig. 14—Fuse and Detonator.

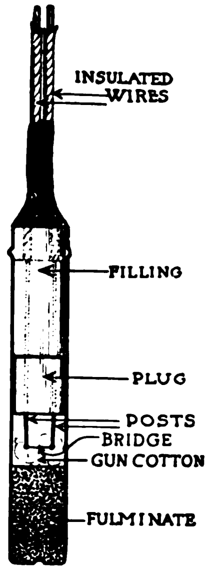

Fig. 15—Sectional View of Electric Detonator.

An electric detonator, or electric blasting cap, serves the same purpose as the detonator or blasting cap used with fuse, but is so constructed that it can be fired by discharging an electric current through it. It consists, as shown in Fig. 15, of a copper shell, containing at its inner end the charge of mercury fulminate, followed sometimes by guncotton, next a waterproof plug and at the outer end a quantity of filling material. Insulated copper wires enter the cap and traverse the filling material and plug, terminating in the fulminate or guncotton. The ends, or posts, of the copper wires are connected by a platinum bridge, which is heated to incandescence by the electric current, thus exploding the charge. Detonators, whether electric or not, are designated by numbers, each number representing a different strength. No. 6, for example, contains 1.00 gram of the charge.

An electric squib, Fig. 16, has been designed to replace the ordinary type of squib when blasting powder is used. It is a paper shell, containing a composition that flames when the electric current passes through it, and thus ignites the blasting powder. It is instantaneous, avoids the fumes that would come from an ordinary squib and is safer.

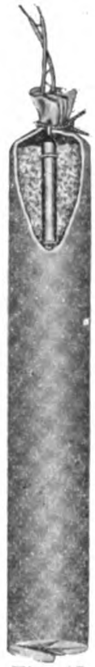

Fig. 17 Primer with Electric Detonator.

Electric Squib (*Actual Size*) Fig. 16.

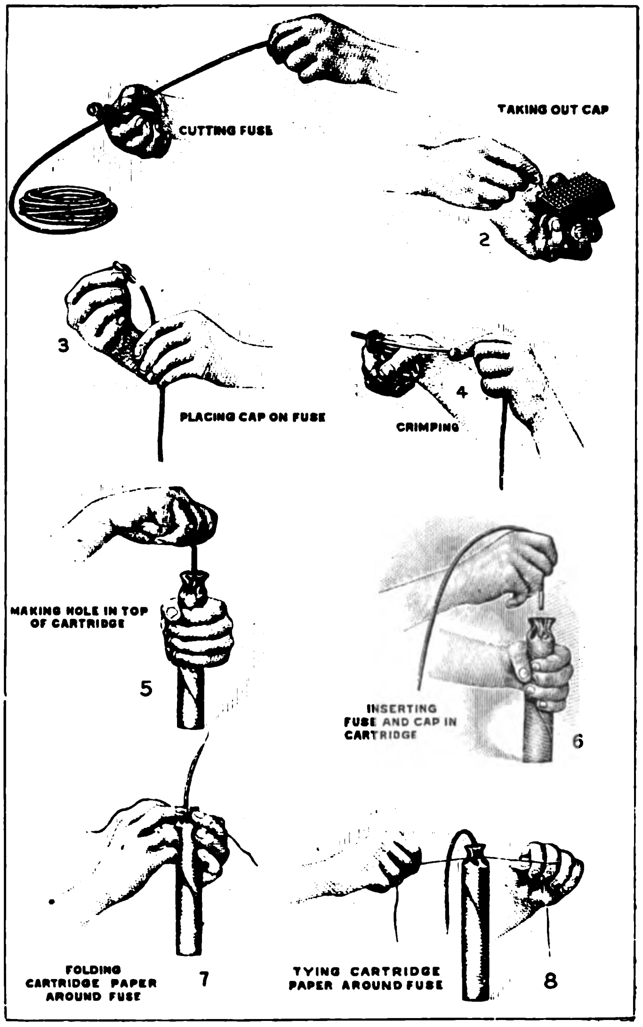
CUTTING FUSE
TAKING OUT CAP
2
3
PLACING CAP ON FUSE
4
CRIMPING
MAKING HOLE IN TOP OF CARTRIDGE
5
INSERTING FUSE AND CAP IN CARTRIDGE
6
FOLDING CARTRIDGE PAPER AROUND FUSE
7
TYING CARTRIDGE PAPER AROUND FUSE
8

Fig. 18—Priming a Cartridge at the End.

If it is desired to fire several shots in succession, detonators may be used that are provided with different lengths of a slow burning composition and are all connected in one electrical circuit. Thus, the order of shots and the time between any two consecutive shots may be arranged at will, only one electrical impulse being required for ignition of all. The method is not in general use, however, in coal mining.

Primer

In the use of high or permissible explosives, only one of the cartridges, usually the outer one of a charge, is in direct contact with a detonator. This cartridge is known as the primer, Fig. 17. The preparation of the primer is shown in Fig. 18.

After the fuse has been inserted into the end of the detonator and the latter crimped on the fuse, the cartridge wrapper is unfolded at one end and a hole is punched in the end of the cartridge by means of a wooden stick. The detonator is imbedded in the explosive material as far as the crimping. Then the loose paper is folded about the fuse and tied with a string.

Another method, Fig. 19, involves the punching of a hole diagonally in the side of the cartridge and inserting in it the detonator, binding the fuse to the outer surface of the cartridge with a string. This method is not so generally accepted, because of the liability of damage to the fuse through abrasion or bending, also because the greatest shock from a detonator is in line with its axis and away from the fuse or wires. The method of passing fuse entirely through a cartridge is a dangerous one, since bends or breaks may thus occur in the fuse, and the explosive may be burned, instead of detonated.

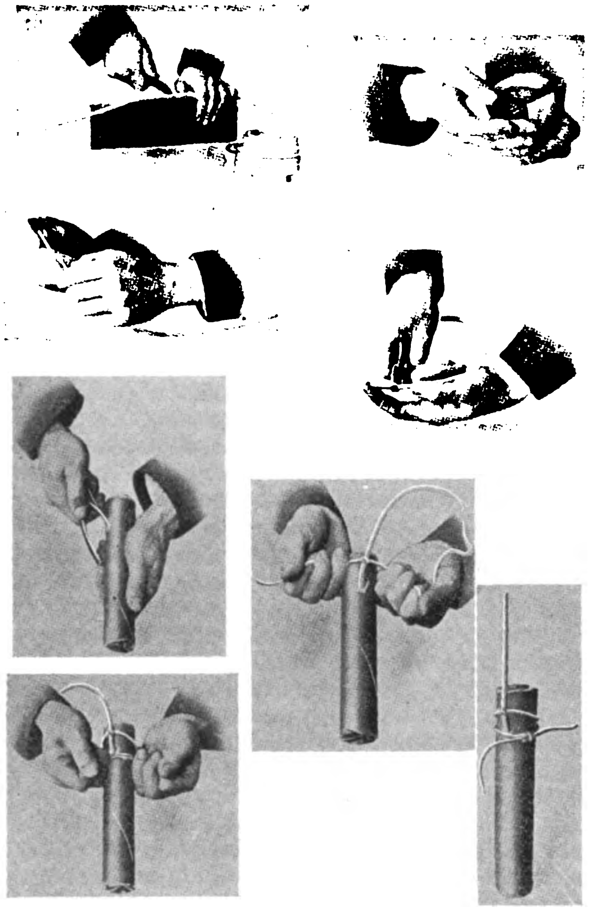

Fig. 19—Priming a Cartridge at the Side.

When electric detonators are used, the primer is prepared similarly, with detonator either in the end or side. Some users recommend the side method for electric detonators, but the practice is by no means universal. A method that has been recommended for making a primer with electric detonator is shown in Fig. 20. The strength of the detonator should be adapted to the work required. One too strong is better than one not strong enough. The use of No. 6 or stronger detonators is recommended for firing permissible explosives. Tests show that explosions are quicker and more complete, and consequently a smaller volume of poisonous gases is generated when such detonators are used. Also, unfavorable conditions, such as age of the explosive, are less effective.

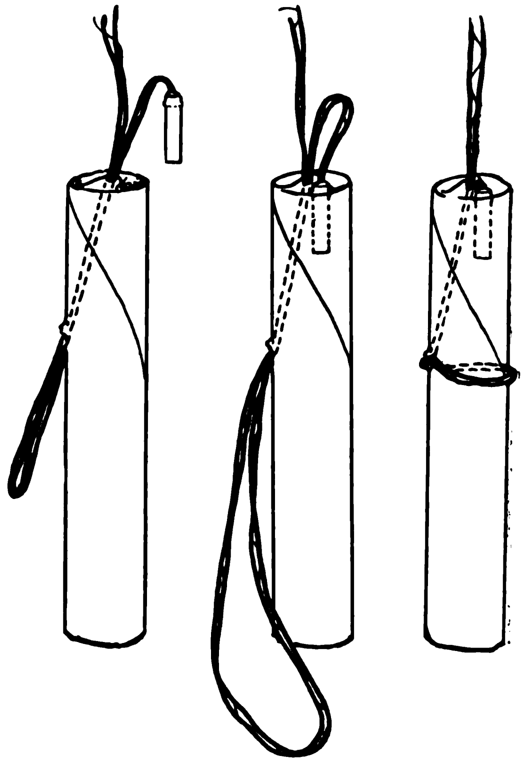

Fig. 20—Method of Priming with Electric Detonator.

Tamping

With the primer properly prepared and placed in the hole outside of the other cartridges, damp clay or other incombustible material is tamped in upon the charge and around the fuse or electric wires extending to the mouth of the hole. The first six inches or so of tamping should be comparatively loose, in order to avoid disturbing the charge and detonator, but the remainder should be packed firmly, since the explosive gives better results on the coal when the resistance of the material in the drill hole is greater. A longitudinal section of the hole is shown in Fig. 21.

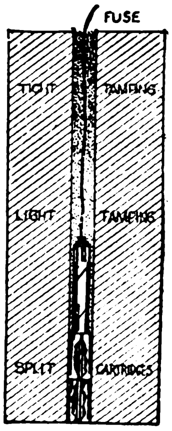

Fig. 21—Section of a Charged Drill Hole.

Electrical Method of Firing

The method of firing shots electrically has many advantages. First of all, it is safer. The charge can only be ignited by the person who controls the electric current, and he does not incur the risk so common with fuse or squib of ignition before he has reached a safe place. Delayed ignition is practically unknown when electricity is used. The danger of igniting gas or dust from squib or fuse flame is absent. Fumes of burning fuse are eliminated. Several shots may be fired simultaneously, thereby increasing the effect over that from firing the same shots separately. Electrical detonation of the eplosive is found to be more complete and efficient.

Electric detonators may be obtained with wires from 4 feet to 20 feet in length. In any case, the wires should be long enough to extend at least a few inches out of the drill holes. At their ends good electrical connection is made to copper leading wires, which in turn are connected to the poles of the blasting machine. Leading wires may be two single wires or one duplex cable. In either case, they are thoroughly insulated. To connect the electric detonators in adjacent holes, when several are to be fired simultaneously, a smaller wire, known as connecting wire, is used, and the detonators are connected in series, as shown in Fig. 22. By this arrangement, the firing of all the detonators is assured, if one is fired.

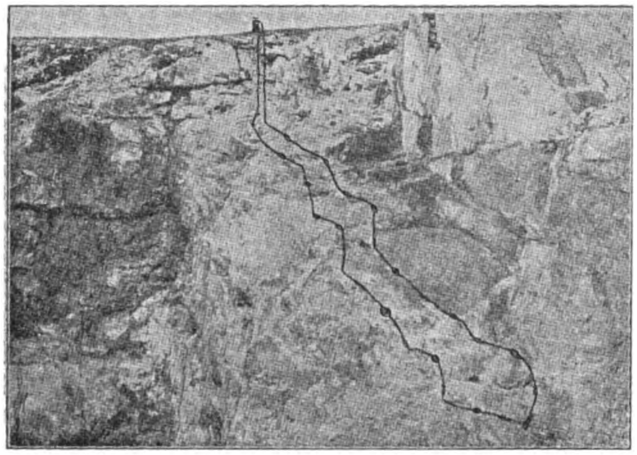

Fig. 22—Blasting Circuit Connected in Series.

The electric current necessary is usually generated with a blasting machine, often called a battery. The machine is essentially a dynamo, in which the input is the blaster's physical energy and the output is electrical energy. The average size of blasting machine for underground use stands about 15 inches high, weighs 20 to 25 pounds and has a capacity for firing 20 to 30 electric detonators simultaneously. Views of a typical two-post machine are shown in Fig. 23. An armature, B, is set between two electro-magnets, A. A rack bar, the handle of which extends above the top of the box, meshes with a pinion, C, on the revolving armature shaft. When the rack bar is pushed down vigorously, a current is generated by the revolution of the armature between the electro-magnets. The strength of the current accumulates until it reaches a maximum when the lower end of the rack bar is at the bottom. At this stage, the rack bar presses down the contact spring, the circuit through the magnets is broken and the current is discharged through the posts at the top, to which are attached the leading wires.

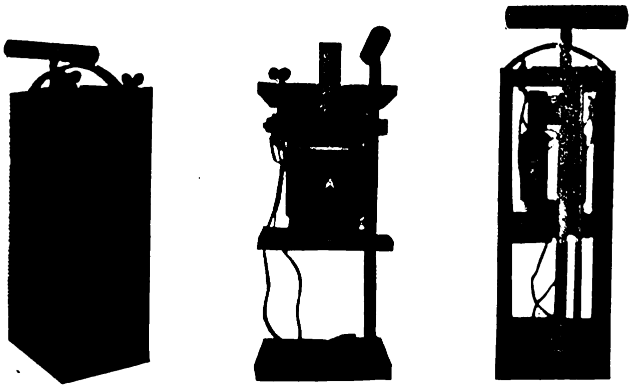

Fig. 23—Two-Post Blasting Machine.

Both larger and smaller blasting machines are on the market. A small one, designated as a pocket machine, Fig. 24, weighs only 4½ pounds, and has a capacity of three detonators. The smaller size is especially convenient in coal mining because of its easier portability, and its capacity is equal to the ordinary requirements in such mines. Its general principles of construction and operation are the same as those of the larger machines. The handle is not pushed down for firing, as in the other types, but is turned about its axis with a vigorous twist. The fact that the handle is detachable makes the machine somewhat safer from unauthorized use.

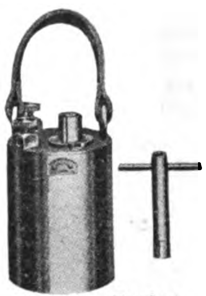

Fig. 24—Pocket Blasting Machine.

When blasting machines are used for firing, there are two tests necessary to make in order that the best results be obtained. One test is for the condition of the circuit, the other for the efficiency of the machine.

The test on the circuit is made with a galvanometer, preferably one of pocket size, designed expressly for this purpose, which consists essentially of a magnetic needle and a dry cell battery, so weak that it incurs no risk of firing a detonator. The resistance of the circuit may be computed, knowing the resistance of the detonators and of the wire used. It may also be taken from tables prepared for the purpose. When the terminals of the system of wiring are connected to the posts of the galvanometer, the needle is deflected through an angle varying inversely as the resistance. Since the scale is graduated to measure the resistance in ohms, the reading may be compared with the computed resistance. Substantial agreement between the two indicates a satisfactory condition of the circuit. A reading lower than the computed value would probably be due to a short circuit, while one above the computed value would be regarded as evidence of a poor connection. By making similar tests on successive portions of the circuit, the faults may be located and remedied.

The test on the blasting machine is made for the purpose of determining its capacity, which may vary with use. If more detonators than the capacity of the machine were put into a circuit for firing simultaneously, some would not fire, or perhaps none would fire. The instrument used for the test is a rheostat, which consists of a number of coils of wire, each with a known resistance, so arranged that any one or more can be connected into an electrical circuit. In making the test, as shown in Fig. 25, coils of the rheostat, R, with resistance equal to that of a certain number of electric detonators are wired into a circuit with a blasting machine and a single detonator. If the machine is now operated in the usual way, the consumption of current is the same as if all the detonators were actually in the circuit. The firing of the single detonator, or the lighting of a lamp in its place, would indicate that the machine had a capacity at least equal to the sum of all the resistances. By successive trials with different resistances, the maximum capacity could be found.

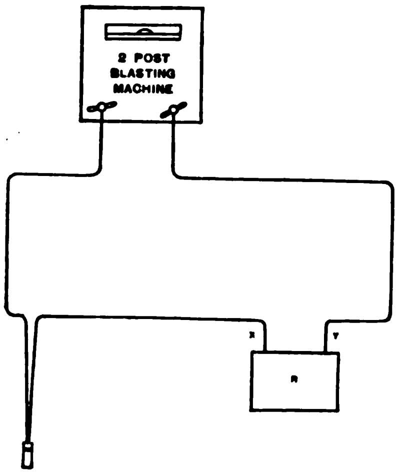

Fig. 25—Use of Rheostat.

Employment of Shot Firers

The old shot firing custom in coal mines permitted each miner to attend to the shots in his own working place. He selected the position of the drill hole, decided upon the angle of the hole and its depth, estimated the charge necessary, prepared the fuse, squib or other means of firing, tamped the hole and lighted the shot. It is evident that there were many opportunities for even fatal error on the part of an inexperienced or careless man. Besides, the miner was allowed to fire shots at any time during the day that was convenient to him, and, consequently, the ventilating current was more or less continuously polluted with the gaseous products of blasting. The danger of igniting gas or coal dust with a blown-out shot was so great that restrictions were placed on individual firing.

Some of the state laws permit the miner only to drill the holes, and place the responsibility of inspecting, charging and firing upon skilled shot firers. While this system may still allow firing throughout the day, the supervision is of great value, and with one man doing all the firing in a certain section of the mine, it becomes more practical to use the electrical method. Shot firers are generally limited to gaseous mines, but in any mine where permissible explosives are used, it is advantageous to employ skilled men for this work. Permissibles give their best results when so used.

The next important step in restriction is to require the firing to be done after the miners have left, and when no person is in the mine except the shot firers. The danger of mine explosions is in no way reduced by this restriction, but in the event of an explosion, the number of persons concerned is small, compared with the total number of employees. No additional protection is afforded to the property. Gaseous mines and those in which solid shooting is permitted are especially benefited by such restrictions.

The system that is safest, so far as human life is concerned, is so extreme that there is little inclination to make it compulsory. It is that of firing by throwing an electric switch on the surface.* after all persons, including the shot firers, have left the mine. All the shots may be fired simultaneously, but if preferred, they may be fired in groups by installing several independent switches and wiring systems, each serving a different portion of the mine, or by connecting several wiring systems in turn to the switch. The power circuit is generally the source of current for firing from the surface, in which case the detonators are connected in parallel, instead of in series, as with the blasting machine. The inspection of the shots is as important as before, and in addition, the shot firer has the duty of maintaining the connections to the surface. Some authorities believe that firing a great number of shots simultaneously involves a greater risk of gas or dust explosion than firing the same number singly, also that the danger to the roof and timbering is increased. Experience has not yet been sufficient to draw definite conclusions, but there is at least one disastrous mine explosion that occurred when firing was done from the surface.† The explosive used in the case cited was black blasting powder.

Thawing

Since many of the high explosives and many of the permissibles contain nitroglycerin, proper and safe methods of thawing are important. It is essential that the heat be moderate, because with increased temperature the explosive is more sensitive to slight shocks, and may even be fired by high temperature alone. Some crude methods, such as carrying in the clothing, placing near a fire or soaking in hot water may be dismissed as obviously unsafe from a consideration of the properties of nitroglycerin.

A simple method that is often practical is the placing of the explosive, enclosed in a tight box, under a pile of fresh and warm stable manure, Fig. 26. There is little danger, if any, of overheating, but care must be taken to prevent moisture from reaching the explosive, and the pile must be renewed at intervals, depending on the air temperature.

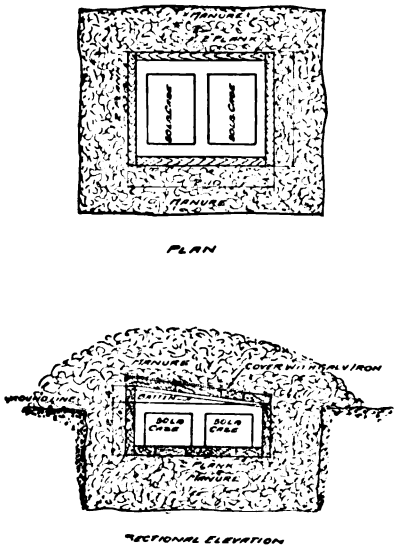

Fig. 26—Thawing Box Surrounded with Manure.

A considerable improvement is the thawing kettle, which has a capacity of 60 pounds of dynamite for the largest size. In external appearance, it resembles a tin pail, but is composed of two parts, an outer shell for hot water and a tight inner compartment, surrounded by the hot water and containing the explosive. Sometimes insulating ma-

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*"Shot Firing in Coal Mines by Electricity Controlled from Outside", Technical Paper 108, Bureau of Mines.
"Shot Firing in Coal Mines by Electric Circuit from the Surface", Transactions American Institute of Mining Engineers, Vol. 50, p. 723.

†"A Setback to Electric Shotfiring", Coal Age, Vol. 2, p. 832.

terial is used to assist in retaining the heat. One type is shown in Fig. 27. It is essential for safety that the heating of the water be completed in another vessel, before the water is placed in the kettle. The temperature should not be greater than can be borne by the hand. A modification of the kettle provides a galvanized iron tube for each cartridge to be thawed, as shown in Fig. 28, instead of placing the cartridges loosely in the inner compartment. By changing the water at intervals, or by protecting against cooling, the explosive may be kept at a temperature suitable for use as long as is generally necessary.

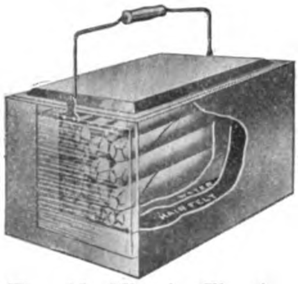

Fig. 27—Miner's Thawing Kettle.

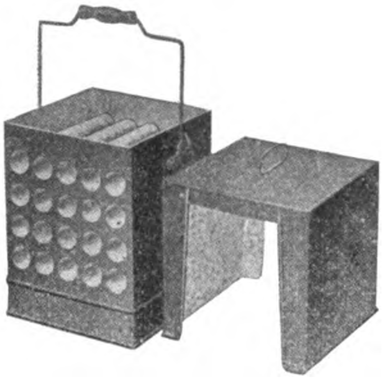

Fig. 28—Tube Thawer.

For thawing large quantities, a thaw house should be erected. An example of such a structure, about 6 feet square and 7 feet high, with capacity of 500 pounds of explosive, is shown in Fig. 29.

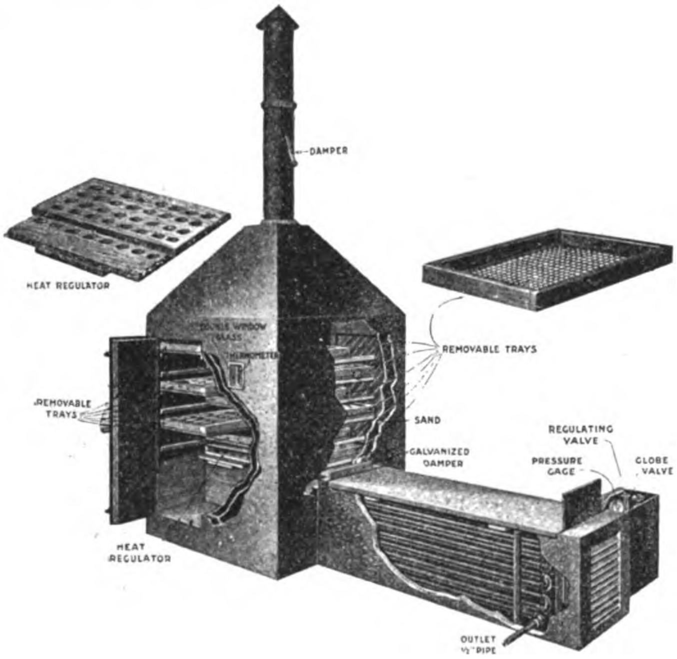

Fig. 29—Thawing House.

Exhaust steam is used for heat, and the steam coils are placed outside the compartment for explosives, in order to keep the temperature within safe limits. Hot water heat is sometimes used.

Storage

It is desirable to use explosives in as fresh a condition as possible, but at most mines the storage of a certain quantity is necessary, and for this purpose, magazines are provided. In no case should the storage space be in the mine. The important requirements are safety from ignition of the explosive and preservation of the explosive in condition for use.

Safety from ignition is attained chiefly by making magazines fireproof and bulletproof, as well as proof against thieves, by locating them at a distance from other buildings and frequented places, by using no metal in the interior of the magazine and by care in handling and piling the packages. Preservation of the explosive is accomplished chiefly by ventilation, protection from the weather and maintaining of proper temperature. In no case should detonators of any type be stored in the same magazine with high or permissible explosives, although it is considered safe to store black powder and high or permissible explosives in the same structure, if different parts are assigned for each. A standard type of magazine is shown in Fig. 30.

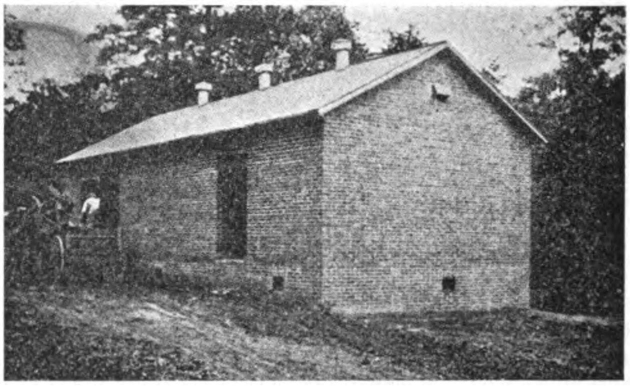

Fig. 30—Magazine.

Brick walls with iron doors are usually considered to make a fireproof structure, although a galvanized covering over wood is effective, particularly when the space between is filled with sand. Fireproof construction should not be depended on entirely, but provision should be made for removal of the contents in case of fire near the magazine. Either of the above is bulletproof on the sides. and roofs are made so with sand packing. The magazine should be solidly built and provided with a secure lock. The proper distance from other buildings depends on the quantity of explosive stored and the character of intervening ground, but laws bearing on this point aim to leave a safe margin. Floors and interior walls are of wood preferably, exposed nails or other iron or steel being avoided. In handling packages of explosives into and out of the magazine, the character of the explosive must be kept in mind; for example, dynamite must be handled so as to avoid dropping the cases, or allowing anything to drop upon the cases. Dynamite is preferably stored so that the cartridges have their long dimension horizontal, to reduce to a minimum the danger of nitroglycerin leakage. Powder kegs should be stored with the axis horizontal, in order to secure ventilation between the kegs. No packages should be opened in or near a magazine.

Ventilation is necessary in order to keep the explosive in normal condition. Too much moisture or too little moisture is likely to change the chemical composition of either class of explosives. Suitable openings in the sides and roof of the building serve the purpose of ventilation. High explosives magazines are heated in cold weather much as thaw houses are heated. In summer, the ventilation serves to reduce the inside temperature.

Portable steel buildings are sometimes used as magazines. Many of the precautions that should be taken are rendered difficult by this type of construction, but for a temporary magazine they serve their purpose. For storing small quantities close to the work, covered iron wagons or low trucks are sometimes used.

Accidents and Precautions

Fatal accidents due to explosives in the bituminous coal mines of the United States constitute about 5 per cent. to 7.5 per cent. of the total. Classification of accidents from this source is given in the following table:*

	Per cent.
Handling and transportation	16.79
Handling caps, detonators, squibs and fuse	1.20
Thawing explosives	.73
Tamping	2.97
Premature blast and short fuse	24.87
Blown-out or windy shot	5.47
Flying pieces of rock or coal	16.71
Returned too soon	7.97
Delayed blast	.90
Shot breaking through pillar or rib	5.88
Suffocation by powder gas	3.45
Striking unexploded charge in removing debris	.08
Drilling into unexploded charge	1.88
Unclassified	11.10
	100.00

It is significant that a decrease in accidents accompanies an increase in the quantity of permissibles used.

Many of the precautions necessary or advisable in the transportation, handling and use of explosives have been mentioned in the pages preceding, and will not be repeated here.

Transportation on the common carriers is controlled by the regulations of the Interstate Commerce Commission and the rules of the American Railway Association. State and local laws govern the transportation elsewhere on surface and underground.

The mining laws of the several states treat in more or less detail the handling and use of the explosives adapted to mining, and are valuable summaries of safe practice in the fields covered by them.

All manufacturers of explosives are interested in having their products used safely, as well as successfully, and to this end have prepared lists of precautions for the guidance of their patrons. In addition, the Institute of Makers of Explosives has published a set of rules that should be observed faithfully in the interest of safety.

If proper precautions are taken, such as would be dictated by ordinary prudence and suggested by the codes of rules named above, the handling of explosives is comparatively safe.

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*"Coal Mine Fatalities in the United States," Bureau of Mines.

NOTE—We are indebted to the following manufacturers for cuts and illustrations appearing in this article:

Aetna Explosive Co., Inc.,
Atlas Powder Co.,
Davis Instrument Mfg. Co.,
E. I. du Pont de Nemours & Company,
Hercules Powder Co.

AETNA EXPLOSIVES COMPANY, Inc.

General Offices
120 BROADWAY, NEW YORK CITY

For any information write to our General Offices or to our nearest Branch Office.

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Sinnamahoning, Pa.

Blasting Powder
Birmingham, Ala.
Goes, Ohio.
Fayville, Ill.

Blasting Supplies
Port Ewen, N. Y.

Manufacturers of

Permissible Powders, Dynamite, Black Powder and Blasting Supplies for all purposes

---

PERMISSIBLE POWDERS

For gaseous and dusty mines we recommend the use of Aetna Permissible Powders. The following table designates the kinds of Permissibles best adapted for use under conditions here specified.

WET WORKINGS

Aetna Coal Powder A
Aetna Coal Powder B
Aetna Coal Powder C
Aetna Coal Powder D
Coal Special No. 1
Coal Special No. 2
Coal Special No. 2-W
Coal Special No. 3-C
Coal Special No. 1-A
Coal Special No. 1-LF
Bituminite No. 1
Bituminite No. 3
Bituminite No. 4
Bituminite No. 8-LF
Collier Powder No. 2

DRY WORKINGS

Aetna Coal Powder AA
Aetna Coal Powder No. 2
Bituminite No. 5
Collier Powder No. 5
Collier Powder No. 5 Special
Collier Powder No. 5-LF
Collier Powder No. 6-LF
Collier Powder No. 9
Collier Powder No. 11
Collier Powder No. 11-LF
Collier Powder X
Collier Powder XLF

HARD WORKINGS

Where quick-acting powder is required and high percentage of lump is not considered.

Bituminite No. 1
Aetna Coal Powder A
Coal Special No. 1
Collier Powder No. 11

SOFT WORKINGS

Where slow-acting powder is required and greatest percentage of lump is desired.

Collier Powder No. 9
Collier Powder X
Aetna Coal Powder C
Bituminite No. 4

POOR VENTILATION

Aetna Coal Powder No. 2
Bituminite No. 5
Collier Powder No. 5
Collier Powder No. 5 Special
Collier Powder XLF
Collier Powder No. 5-LF

MINES NOT REQUIRING PERMISSIBLE POWDERS

In mines free from gas and dust, where ventilation is good and lump coal is desired, Aetna Black Blasting Powder can be used to good advantage. If the ventilation is poor, and less lump is required, Aetna Gelatin, Aetna Standard (Ammonia) and Aetna Low Freezing Standard (L. F. Ammonia) brands of Dynamite are recommended, as these grades produce a maximum explosive effect combined with freedom from fumes. For tunnel driving in hard rock, use Aetna Gelatin, and in softer material use Aetna Standard Gelatin.

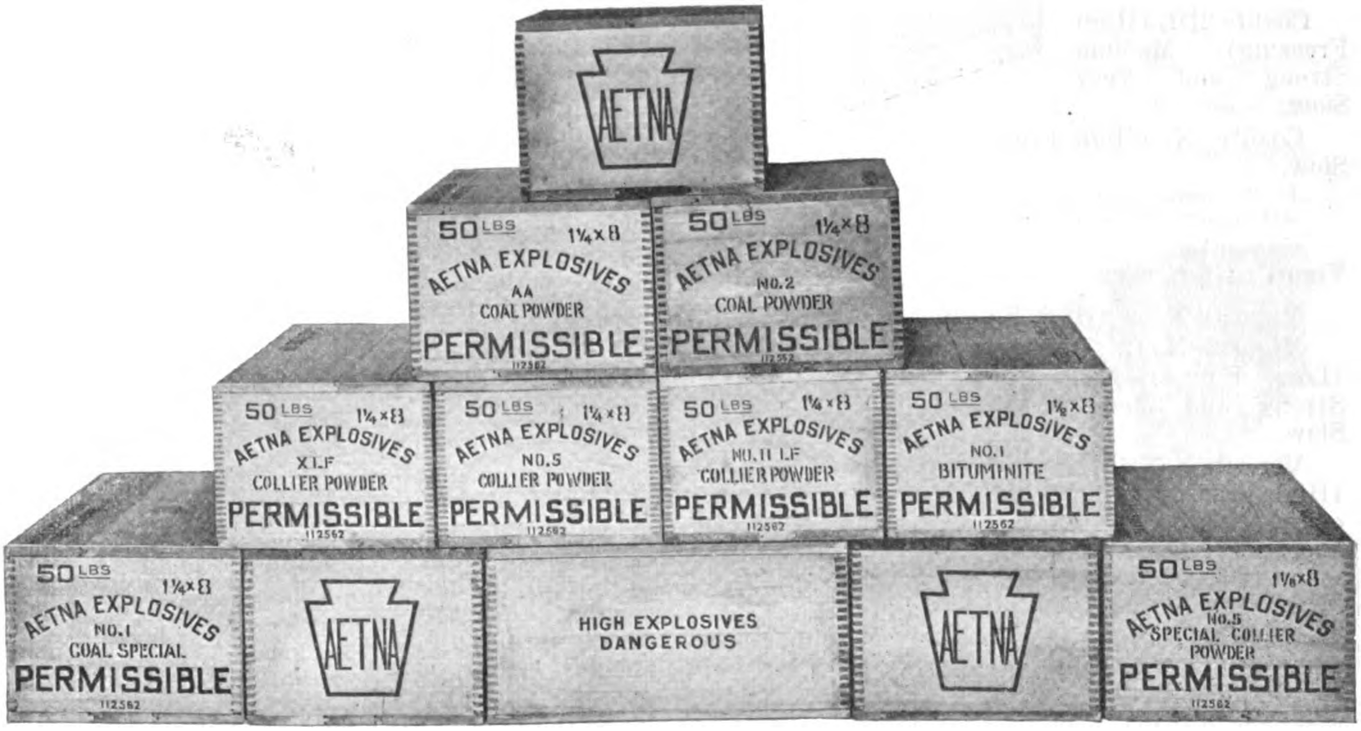
Black Blasting Powder

Aetna Black Blasting Powder is made in seven standard granulations, ranging from FFFF, or the finest and quickest burning, to CCC, or the coarsest and slowest burning. Black Blasting Powder is admirably adapted for use where Mines are free from gas and dust and where lump coal is desired.

Blasting Supplies

Aetna "Lion" Brand Blasting Caps, Electric Blasting Caps, Blasting Machines, Galvanometers and Rheostats; Fuse, Cap Crimpers, Leading Wire and Connecting Wire promptly shipped direct from factories or from well-stocked magazines at our various distributing points.

Don't hesitate to consult us if you have any blasting problems upon which you wish advice. Our men in the field are in close touch with every variety of work requiring explosives and are at your serivce at all times.



ATLAS POWDER CO.

WILMINGTON, DEL.

Blasting Explosives Blasting Supplies

Atlas Permissible Explosives for Gassy and Dusty Coal Mines

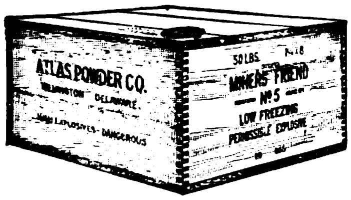
Damp proof—Not water proof. No harmful smoke or fumes. Sensitive to No. 6 Detonator.

Miners Friend—6 Grades.

Miners Friend No. 1 (High Freezing); Miners Friend No. 6 (Low Freezing); Very Strong and Medium Slow.

Miners Friend No. 2 (High Freezing); Miners Friend No. 4 (Low Freezing); Very Strong and Slow.

Miners Friend No. 3 (High Freezing); Miners Friend No. 5 (Low Freezing); Very Strong and Very Slow.

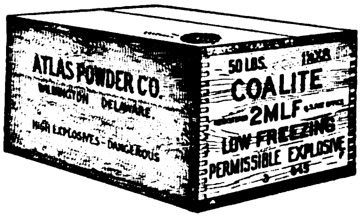


Coalite—6 Grades.

Coalite No. 1 (High Freezing) Strong and Slow.

Coalite 2D (High Freezing); Coalite 2 MLF (Low Freezing); Coalite 3XC (High Freezing); Medium Strong and Slow.

Coalite 2DL (High Freezing) Medium Strong and Very Slow.



Coalite X (High Freezing) Very Strong and Slow.

Vigorite—6 Grades.

Vigorite No. 1 (High Freezing).

Vigorite No. 2 (High Freezing); Vigorite No. 5 (Low Freezing); Strong and Medium Slow.

Vigorite No. 3 (High Freezing); Vigorite No. 6 (Low Freezing); Medium Strong and Medium Slow.

Vigorite No. 4 (High Freezing) Medium Strong and Very Slow.

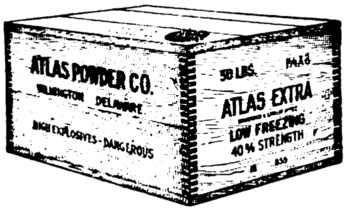
Put up in cartridges ⅞ in. x 8 in. to 1¾ in. x 8 in. and packed in 25 lb. and 50 lb. cases.

Dynamite

Each strength and kind made either high or low freezing. Sensitive to No. 6 Detonator.

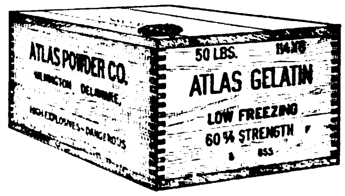
Atlas Extra—20% to 60%.

Spreads and heaves when exploded. Fumes not objectionable. Not waterproof. For headings, strippings, cuts and other rock or coal blasting that is not wet or gassy.



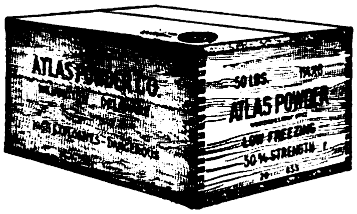
Atlas Gelatin—35% to 100%.

Almost non-freezing. Practically fumeless. Waterproof. For tunnel driving and rock blasting of all kinds in mines or under water.



Atlas Powder—20% to 60%.

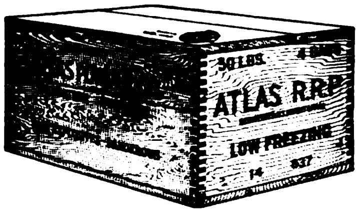
Very quick and shattering. Fumes objectionable under ground. Partly waterproof. For outside work in hard rock that must be broken small.



Low Powder

Atlas Low Freezing R. R. P.

A granular, low grade explosive invaluable in cuts, strippings or other open excavating that is not wet. Twice as strong as blasting powder. Exploded with a dynamite primer. Put up in 12½ lb. paper bags, packed in 50 lb. cases.



Atlas Blasting Powder

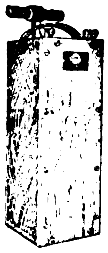
All Standard granulations from FFFF to CCC. The smaller the grain the quicker and more shattering the powder.

Hard pressed, dense, regular, moisture-resisting grains. Little smoke. Glazed or unglazed. Packed in 25 lb. kegs and 5 lb. cans.

U. S. Standard Blasting Machines

This is a light weight blasting machine, especially made for coal mining where it is not necessary to fire more than two or three charges at a time. It has a capacity of 3 copper wire electric fuzes. It weighs 4½ pounds. It is furnished with a removable handle which prevents its being operated by any other person than the blaster. It is equipped with two posts only.

Atlas Little Giant.


No. 3.

Standard size for quarry and mine. Capacity 30 copper wire electric fuzes.. Weight 25 pounds. Regularly equipped with two posts. A strong, substantially built machine that can be depended on to develop its maximum capacity if kept dry and operated with full force.

This blasting machine, while operated like the others, is of a different type, embodying many refinements of design, giving a machine of great power and light weight. It has a capacity of 150 copper wire electric fuzes, and is, by far, the most powerful blasting machine made. It has two posts and weighs only 37 pounds.

No. 6.

Fuse

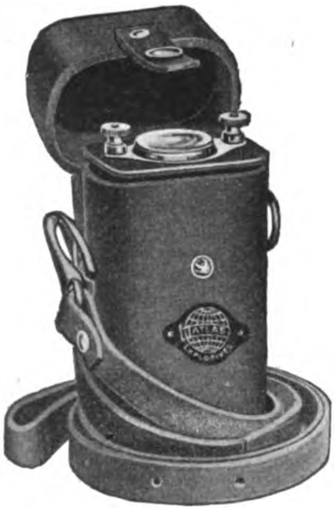
Wrapped in rolls of 100 feet. Ten to sixty rolls to the case.

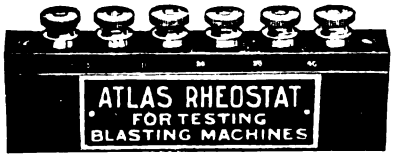
For Wet Work
"CHARTER OAK"

For Wet Work
"CLOVER"

For Dry or Damp Work
"Beaver"

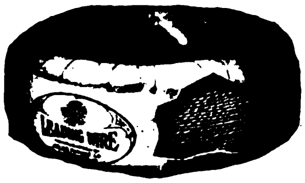
Galvanometers and Rheostats


Atlas Galvanometer for Testing Blasting Circuits.

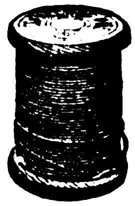


Atlas Rheostat for Testing Blasting Machines.

Insulated Copper Leading Wire and Connecting Wir



Coil of Leading Wire.


Spool of Connecting Wire.

Leading Wire—250 ft. and 500 ft. Coils. Weighs about 9½ lbs. per M ft.

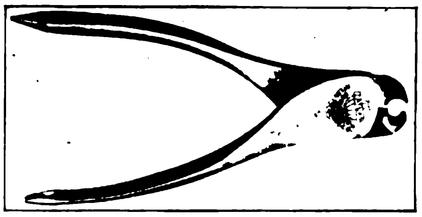
Connecting Wire—1 lb. and 2 lb. Spools. About 210 ft. to the pound.

Leading and connecting wire are sold by the pound.

Blasting Caps—No. 6, No. 8.

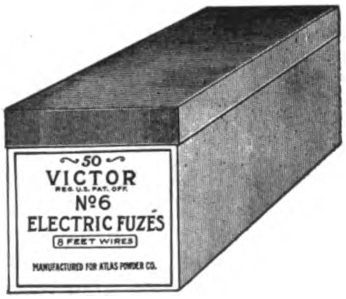
Packed 25 or 100 to the tin box—500 to 5,000 to the case.

Atlas Cap Crimpers



The only safe, secure and reliable way to attach a blasting cap to fuse is with a cap crimper.

Victor Electric Fuzes—No. 6, No. 8. Copper or Iron Wires.



Packed 25 and 50 to the carton—ten cartons to the case. Wires 4 ft. to 30 ft. long.

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AUSTIN POWDER COMPANY

CLEVELAND, OHIO

1229 Rockefeller Building

Established in
1833.

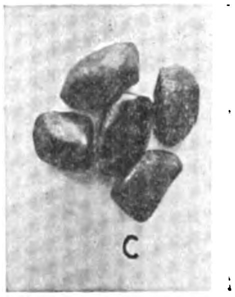
Factory at
FALLS JUNCTION, O.

Branch Offices at
DETROIT,
ST. LOUIS,
CHICAGO.

Blasting Powder, Dynamite, Blasting Supplies

CCC

CC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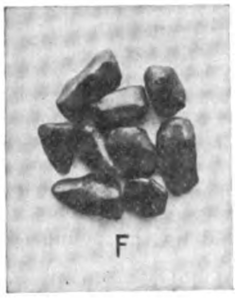
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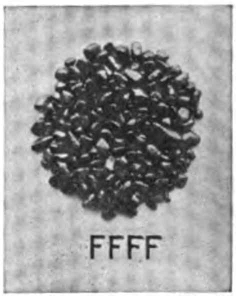
FFFF

Austin Blasting Powder is manufactured of the best materials obtainable, and is of uniform quality and size. It is the standard powder for coal mining, and has been for many years. For other kinds of blasting it has no equal. It is made in seven sizes, and is calculated to meet every need in the blasting line, where Black Powder can be used at all.

Where High Explosives are required, we recommend "GOLD MEDAL" Dynamite, which is all that its name implies, and is manufactured in many different strengths, both in Nitro Glycerine and Ammonia grades. You are bound to get results by using "GOLD MEDAL."

A complete stock of "Gold Medal" Dynamite and Blasting Supplies is carried at Cleveland, and at our branch offices.

Our shipping facilities are unequalled, ensuring our customers prompt service at all times. Write for prices.

Gold Medal Dynamite

GRASSELLI POWDER COMPANY

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Manufacturers of

Black Blasting Powder, Permissible Explosives Dynamite

Permissibles

Grasselli permissible powders, Mine-ite, Fuel-ite and Cameron, are made in various grades to meet the many conditions of coal mining. Before submitting any of these grades for approval of the United States Bureau of Mines, coal mining conditions and requirements were carefully studied and exhaustive tests made enabling us to produce a line of permissibles insuring the greatest safety to the miner and reducing production costs.

There are many conditions to be taken into consideration when choosing permissible powders, such as height of vein, texture of coal, position and size of binder, if any, and kind of coal desired. Also, if the undercut is made by chain machine, punching machine, or is hand-mined.

Fuel-ite No. 3

Of quick smashing action. The best permissible for producing coking coal and shooting coal of extremely hard texture.

Fuel-ite No. 3 L.F.

Same as Fuel-ite No. 3 but is low-freezing.

Cameron No. 1-A

Similar to Fuel-ite but faster and of greater expansion.

Mine-ite 6-D

Not quite as speedy a powder as Fuel-ite but of enormous pressure. It is so balanced as to speed, expansion, U. D. C., etc., as to make it especially adapted to lump coal production. Practically fumeness.

Mine-ite 5-D

Where chain or punching machines are used and coal is not of an extremely hard nature Mine-ite 5-D is the most economical powder to use. It is extremely low of flame, which is of very short duration, making it most desirable for very gaseous mines.

Mine-ite A and Mine-ite A-2

A Nitro-Glycerine-base powder of relatively high detonation, recommended for use in hard-shooting coal. It has tremendous breaking power.

Mine-ite B

Develops its gases slowly and is particularly adapted to shooting in soft, easily shattered coal, or wherever lump or steam coal is desired.

Dynamite

Grasselli Powder Co.'s dynamites are sold under the registered trade mark, "GOOD LUCK", which is stenciled on each cartridge and box.

Ammonia Grade

Of great heaving and spreading power. For rock work or coal shooting in mines not gaseous.

Nitro-Glycerine Grade

Of powerful concentrated and hard-hitting action. For outside work. Not suitable for underground work because of fumes.

Gelatin Grade

For driving tunnels and other underground work. Shoots in water and is free from objectionable fumes.

Special Powder

R. R. P. is a granular powder for use where an explosive not quite as strong as dynamite, but stronger than black powder is required. Put up in 12½ lbs. paper sacks packed in 50 lb. cases.

F, FF and FFF granular powders for same purpose as R. R. P. of graduated strengths put up in cartridge form.

Blasting Powder—"Burton" Brand

For use in mines that are not sufficiently gaseous or dusty to be dangerous.

Many of the factors to be considered in the choice of permissible powders must be taken into account when deciding on a grade of blasting powder.

The formulas followed in the manufacture of the various grades of black blasting powder differ only slightly, but the methods and thoroughness of treatment vary greatly. "Burton" Brand powder is made of carefully selected raw materials, thoroughly incorporated, hard pressed and well glazed, insuring maximum of energy.

It is put up in several sizes of granulation ranging from CCC for operations requiring a slow heaving and lifting action to FFFF for shooting a hard coal requiring a sharp smashing action.

A complete stock of Blasting Supplies, such as fuse, caps and electric caps, is also carried at the above distributing points.

The Grasselli Powder Company's salesmen are practical coal miners and expert shooters. If you are confronted with any particular blasting problem, their services are at your disposal.

E. I. du Pont de Nemours & Company

General Offices:—WILMINGTON, DEL.

DU PONT MANUFACTURERS OF DU PONT

Permissible Explosives, Blasting Powder and Blasting Supplies

EXPLOSIVES FOR ALL PURPOSES

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Works:

Blasting Powder.
AUGUSTA, COLO.
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Permissibles.
ASHBURN, MO.
DU PONT, WASH.
LOUVIERS, COLO.
GIBBSTOWN, N. J.

Blasting Supplies.
POMPTON LAKES, N. J.

Products

For Coal Mine Use: Monobel and Carbonite Permissible Explosives, Du Pont Blasting Powder and Blasting Supplies.

Quality and Service

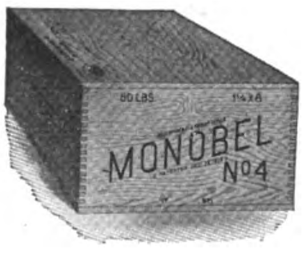
The Du Pont Company has been making explosives since 1802. It has but one standard of quality for its products,—the highest.

Extensive experimental and testing laboratories are maintained to keep Du Pont products apace with the most modern explosive requirements.

The number and location of its works and its extensive system of storage magazines assure prompt delivery.

Monobel Permissible Explosives
(Passed U. S. Govt. tests.)

For use in gaseous and dusty coal mines that are not very wet. They are practically fumeless when properly detonated. (Require a Du Pont No. 6 blasting cap or electric blasting cap.) Give off very little smoke and fumes.



Monobel No. 4

(Low-freezing). For blasting hard coal this grade is much better than blasting powder or dynamite, because it makes no injurious smoke or fumes, and because, after a little practice, a miner can mine the coal cheaper. It is a little slower in its action than Monobel No. 6. Monobel No. 4 will rarely freeze even in the coldest weather. Requires no thawing.

Monobel No. 5

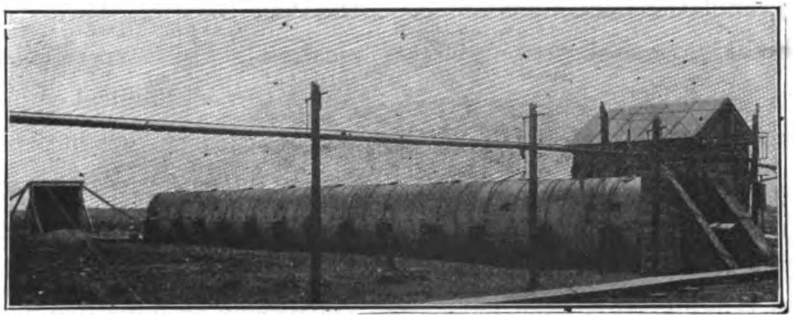
(Low-freezing). Especially adapted to mining lump coal. It is just as strong as Monobel No. 4 but is so much slower acting that miners who have learned how to use it can mine the softest coal without breaking or shattering it any more, and at no greater expense, than if blasting powder is used. Monobel No. 5 rarely freezes no matter how cold the weather. Requires no thawing.

Monobel No. 6

(Low-freezing). Intended particularly for hard coal, hard-shooting soft coal, soft coal which is to be coked, and blasting top and bottom rock. It is a little quicker than Monobel No. 4. Requires no thawing.

Monobel Nos. 1, 2, and 3

Are the same as Monobel Nos. 6, 4 and 5 respectively, except that they (Nos. 1, 2, 3) are not low-freezing. Monobel Nos. 1 and 2 require no thawing, but Monobel No. 3, if frozen, must be thawed before being used.



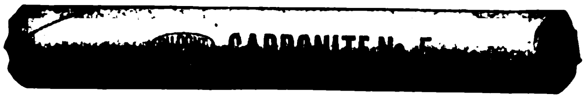
Du Pont Testing Gallery for Permissible Explosives at Gibbstown, N. J.

This is the only testing gallery in the United States for testing Permissible Explosives, maintained on a scale equal to that of the United States Government testing gallery at Pittsburgh.

Carbonite Permissible Explosives

(Passed U. S. Govt. tests.)

For very wet work in gaseous and dusty coal mines. Unless the work is exceptionally wet there is no disadvantage in slitting the Carbonite cartridge if the shot is fired immediately. Gives off a little more smoke and fumes than Monobel but much less than blasting powder or dynamite.



Carbonite No. 1

Is quick acting, for use in anthracite coal and bituminous coal which it is desired to shatter for coking purposes. It has the most shattering effect of all the Carbonite grades. Freezes between 45° and 50° F. When frozen, must be thawed before using.

Carbonite No. 4

Is about 20% slower in velocity of detonation than Carbonite No. 3. Its shattering effect is the least of any of the Carbonites. It is slightly denser than Carbonite No. 3 but not quite so dense as Carbonite No. 1. In water resisting properties, strength and fumes, it is equal to Carbonite No. 3. Freezes between 45° and 50° F. When frozen must be thawed before using.

Carbonite No. 5

(Low-freezing). Its shattering effect is less than Carbonite No. 1. Will often not require thawing even if subjected to temperatures considerably below 35° F.

Carbonite No. 6

(Low-freezing). This grade is quite slow in action. Should be used in all softer and more friable bituminous coal where lump coal is desired. Its shattering effect is less than either Carbonite No. 1 or Carbonite No. 5. Will often not require thawing even if submitted to temperatures considerably below 35° F.

Carbonites Nos. 2 and 3 are the same as Carbonites Nos. 5 and 6, respectively, except that they (Nos. 2 and 3) are not low-freezing. Carbonites Nos. 2 and 3 freeze between 45° and 50° F.

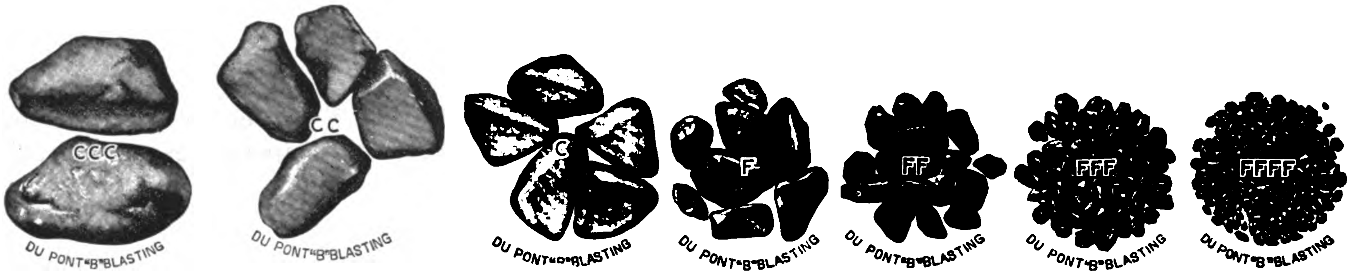
When frozen all Carbonites must be thawed before using.

Du Pont Blasting Powder

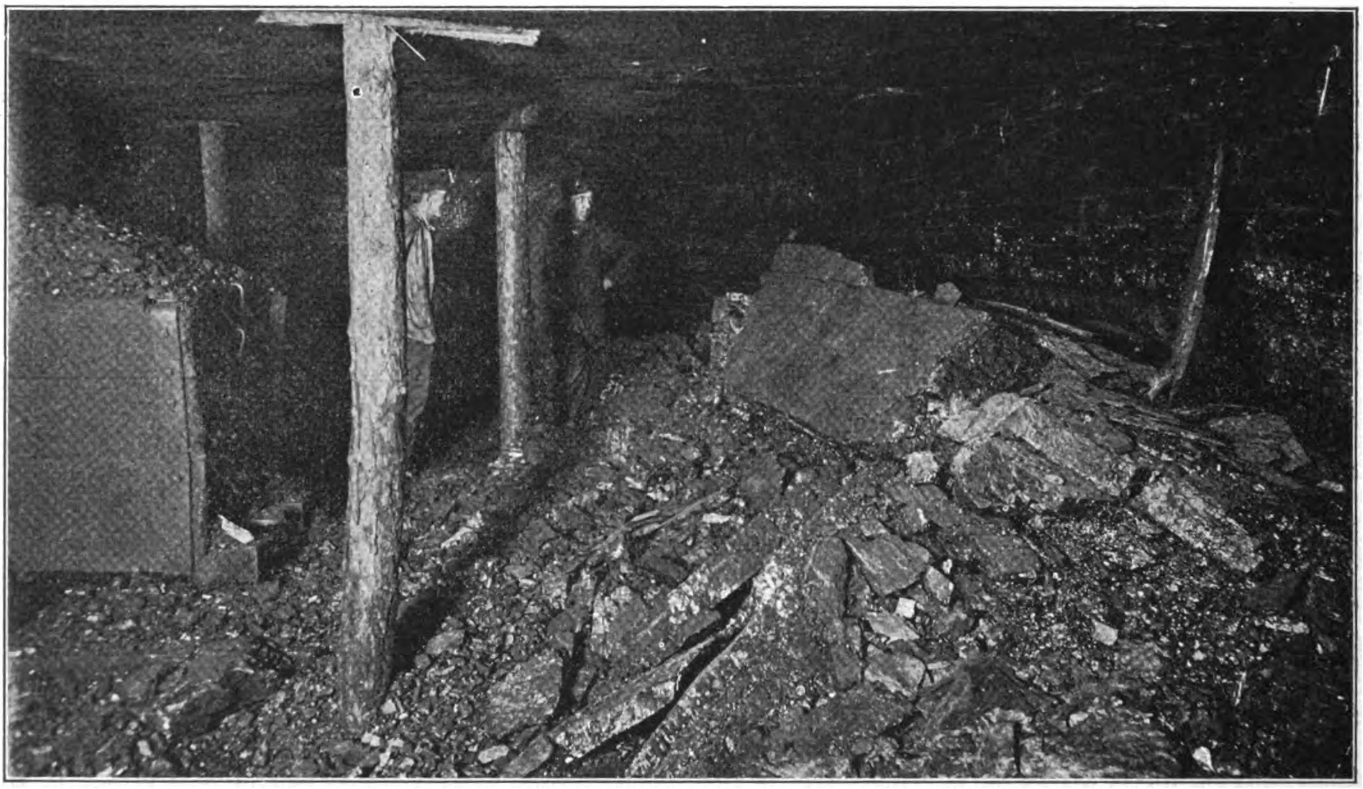
Where mine gas and coal dust are not present in dangerous quantities, the most economical and satisfactory explosive for use in coal mines is B Blasting Powder.

Blasting powder is made in but one strength,—its adaptability to different kinds of work being controlled by regulating its quickness of action. This is accomplished by producing it in grains of different sizes. The finer granulations are much quicker and have a greater breaking and shattering effect than the coarser ones, which latter have more of a tendency to lift and heave the coal out in large lumps.

Du Pont B Blasting Powder is made in seven standard granulations ranging from CCC (coarse) to FFFF (fine). This range of grain sizes insures the coal miner surely finding a size granulation that will just suit his particular work. The greatest care is exercised to insure only the purest and best of raw materials entering into the manufacture of Du Pont Blasting Powder. Our workmen are the most skilled and experienced powder-makers in the world. Our mechanical equipment is the most modern, insuring perfect incorporation of materials. A system of rigid inspection during the whole course of manufacture, and of the finished product, makes certain that the user of Du Pont Blasting Powder will receive an explosive as perfect as human skill and intelligence can make.



Standard Granulations of Du Pont Blasting Powder.



Monobel Shot in an Alabama Coal Mine.

DU PONT BLASTING SUPPLIES

Too much stress can hardly be laid on the importance of using reliable blasting supplies. The best supplies cost but a trifle in comparison with the value of the explosives with which they are used. Poor supplies frequently result in waste of the explosive and loss of life through partial or complete failure to detonate.

We know that the blasting supplies we manufacture and sell are absolutely reliable. Use them and they will bring out the best of which your explosives are capable; if you use Du Pont Blasting Supplies with Du Pont Explosives, you have the ideal combination for maximum efficiency, low cost and general all-round satisfaction.

Electric Blasting Caps
Delay Electric Blasting Caps
Delay Electric Igniters
Connecting Wire
Leading Wire
Blasting Machines
Galvanometers (for testing blasting circuits)
Rheostats (for testing blasting machines)
Electric Squibs
Blasting Caps
Fuse
Cap Crimpers
Thawing Kettles
Tamping Bags
Blasting Mats

Special Literature

One or all of the following booklets will be freely sent on request to anyone interested in the use of explosives: "Permissible Explosives," "Blasting Powder" and "Blasting Supplies." In addition to the data about our own products, these books contain much general information of great value to technical and practical men who have occasion to use or buy explosives and supplies.

Du Pont Blasting Machines

We describe and illustrate two of several types of blasting machines. A descriptive folder giving capacity, weight and price of all DU PONT BLASTING MACHINES sent on request.

No. 3 Machine

Standard size for quarry and mine. Capacity 30 electric blasting caps with copper wires. Weight 25 pounds. Regularly equipped with two posts. Due to its size this blasting machine can be easily operated with best results. It is recommended for all general blasting operations, where a larger blasting machine is not necessary, and even where a smaller one, except the pocket blasting machine, will do the work.

Pocket Size

This is a light weight machine, especially made for coal mining, where it is not often required to fire more than one or two charges at a time. It has a capacity of 3 electric blasting caps. It weighs 4½ pounds. It is furnished with a removable handle, which prevents its being operated by any other person than the blaster. It is equipped with two posts only. When operating, the handle should be given a sharp, quick twist.

No. 3 Machine.

Pocket Machine.

Du Pont Electric Blasting Caps

Are made in two strengths, No. 6 and No. 8, having either copper or iron insulated wires. Copper wires are carried in stock in lengths from 4 feet to 30 feet, but longer lengths may be secured on special orders. Iron wires range in lengths from 2 feet to 8 feet,—longer lengths not being recommended on account of the high electrical resistance of iron wires. The No. 6 have a RED LABEL while the No. 8 have a Green Label. The No. 8 contain twice the charge of explosive material as the No. 6. Although the No. 8 cost more, they are the most economical especially in tunnel and shaft work and where large charges of explosives are used.

Galvanometers

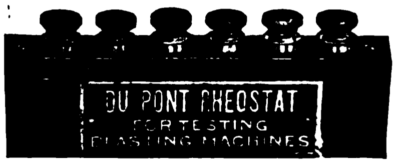
A Galvanometer is one of the most necessary accessories for blasting, as by its use it is possible to determine positively whether the electric circuit is complete or broken or whether it is short circuited.

It is also possible to determine the presence of any broken wires in the Electric Blasting Caps, even after they have been loaded. It is a positive necessity on work where much time is ordinarily lost looking for causes of misfire.

Rheostats are instruments used for testing Blasting Machines. By their use in connection with an Electric Blasting Cap it is possible to determine not only whether a Blasting Machine is up to its full strength, but also how many Electric Blasting Caps it can be depended upon to fire.

No. 6 Electric Blasting Cap.

Galvanometer.



HERCULES POWDER CO.

Branch Offices.
Hazleton .... Pa.
Pittsburgh ...... Pa.
Chicago .... Ill.
St. Louis.........Mo.
New York......N. Y.

General Offices,
Wilmington, Delaware
Subsidiary:
HERCULES POWDER SALES CO.
Memphis, Tenn. Knoxville, Tenn.

Branch Offices.
Joplin .... Mo.
Pittsburg ..... Kans.
Salt Lake City, Utah.
San Francisco....Cal.
Denver .... Colo.

MILLS
Black Powder.
Ferndale .... Pa.
Youngstown ... Ohio.
Columbus ..... Kans.
Pleasant Prairie, Wis.
Marlow .... Tenn.
Bacchus .... Utah
Hercules .... Cal.

Dynamite.
Kenvil..........N. J.
Joplin .... Mo.
Hercules .... Cal.
Bacchus .... Utah

Manufacturers of

High Explosives, Blasting Powders and Blasting Supplies

Products

Permissible Explosives: Red H and Xpdite; Gelatin Dynamite; Blasting Gelatin; Nitroglycerin Dynamite; Ammonia (Extra) Dynamite; Low Freezing Dynamites; Blasting Powders; Hercules R. R. P., F, FF, and FFF Granular Dynamites. Blasting Supplies: Blasting Machines, Galvanometers, Rheostats, Blasting Caps, Miner's Squibs, Electric Squibs, Delay-Action Exploders, Delay Electric Igniters, Leading Wire, Connecting Wire, Lead Splitters, Waterproof Cap Protectors, Kapseal Waterproofing material, Fuse, Thawing Kettles, Tamping Bags, and Cap Crimpers.

HERCULES HIGH EXPLOSIVES

Hercules Permissible Explosives

The Hercules Powder Company manufactures two series of Permissible Explosives for use in gaseous and dusty coal mines, which have passed the rigid tests of the U. S. Government Testing Station at Pittsburgh, Pa.

Ammonium Nitrate Class	Nitroglycerin Class
Red H Nos. 1 to 6.	Xpdite Nos. 1 to 6.

Red H

The Red H Permissible Powders are the products of a careful study of the requirements of an explosive for use in gaseous and dusty coal mines and no other dynamites produce less noxious fumes. Nos. 1, 2 and 3 are High Freezing and 4, 5 and 6 Low Freezing. However Red H No. 3, is the only one that requires thawing. Red H. Nos. 1 and 2 can be used when frozen provided the priming cartridge is loosened up enough to permit the proper placing of the detonator. No. 1 is the quickest and has the greatest smashing effect. It together with Nos. 2 and 6, is used for shooting in hard anthracite or bituminous coal for coking purposes. Nos. 3, 4 and 5 have a slow rate of detonation and are lump coal producers. Cartridges are packed in 25 and 50 lb. cases.

Xpdite

For wet coal mining where permissibles are required, the Xpdite explosives will give the most satisfactory results. Where a quick-smashing shot is necessary, use Xpdite No. 1 or No. 2. No. 3 is a trifle slower than these and No. 4 is the slowest. Nos. 5 and 6 are made on low freezing formulae and correspond to Nos. 2 and 3 respectively. Cartridges are packed in 25 and 50 lb cases.

Hercules Gelatin Dynamite

This is a dense plastic explosive particularly adapted for tight rock shooting. It has the best water resisting qualities and least noxious fumes. Therefore, it is adapted for poorly ventilated underground workings, for wet work, and for submarine blasting. Gelatin Dynamite is manufactured in strengths, 35 to 80% on both the regular and low freezing formulae. Cartridges are packed in 25 and 50 lb. cases.

Hercules Blasting Gelatin

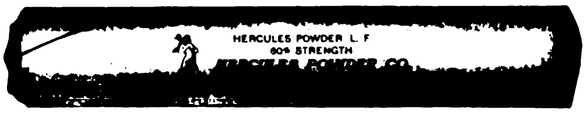
This is the strongest and quickest explosive in existence, having a rated strength of 100%. It is dense, waterproof and produces practically no noxious fumes. It has a consistency of fine Para rubber, being very elastic. Its principal use is for cut holes in hard rock tunnel blasts, loads at the bottom of deep well drilled holes in hard rock, primers for Gelatin Dynamite under special sircumstances, etc. Cartridges packed in 25 and 50 lb. cases.

Hercules Nitroglycerin Dynamites

Very quick acting explosives to be used where a smashing effect is necessary. They have better water resisting qualities than Ammonia (Extra) Dynamites. Manufactured on High Freezing formula from 15% to 60%, and on Low Freezing formula from 20% to 60%. Cartridges are packed in 25 and 50 lb. cases.

Hercules Ammonia (Extra) Dynamites

The Ammonia dynamites are nitroglycerin dynamites in which part of the nitroglycerin has been replaced by nitrate of ammonia. They are excellent explosives for general all-round work. They are manufactured on the regular and Low Freezing formulae in strengths 20% to 60%. Cartridges are packed in 25 and 50 lb. cases.



Hercules R. R. P.

Hercules R. R. P. is a black granular high explosive containing 5% of Nitroglycerin. The grains are made hard. The Nitroglycerin coats the grains and is not absorbed by them. This powder is packed in paraffined paper bags holding 12½ pounds net weight powder and is packed 4 bags to the 50 pound case. For a primer use one pound of 40% or stronger dynamite for every 25 pounds of Hercules R. R. P. For hard rock the proportion may be raised to one to ten. The principal uses of Hercules R. R. P. are large blasts in rock which is too hard for blasting powder or seamy to permit it to exert its full force.

Hercules Powders F, FF, and FFF

These powders are similar to the R. R. P. group but contain different amounts of nitroglycerin as follows: Hercules F, 10%. Hercules FF, 15%. Hercules FFF, 20%.

For 10% and above no dynamite primer is necessary. These powders are packed in cartridges the same as other high explosives.

HERCULES BLASTING POWDER

Hercules "B" Blasting Powder

The Hercules Powder Company manufactures a high grade of "B" Blasting Powder for use in non-gaseous coal mines, coal strippings, quarries and construction work. It is manufactured in all sizes of grains, glazed and unglazed, from FFFF (about 1/16 inch diameter) to CCC (about 1 1/2 inch diameter) running from fine to coarse. A special granulation called RR is made for large blasts. This consists of a mixture of FF, FFF and FFFF grains, designed to fill the spaces between the large grains with small ones.

"HERCULES BLASTING SUPPLIES

Hercules Blasting Machines

Generate current for firing electric blasting caps, electric squibs, and electric igniters. Designed for series connection only. Made in six sizes, and capable of detonating 4 to 150 shots in series as follows:

No. 1, 4 electric blasting caps.
No. 2, 10 electric blasting caps.
No. 3, 30 electric blasting caps.
No. 4, 50 electric blasting caps.
No. 5, 100 electric blasting caps.
No. 6, 150 electric blasting caps.

Hercules Galvanometer

A reliable and compact instrument for testing electric blasting circuits and electric blasting caps, and for locating breaks, short circuits, faulty connections, etc. Weight 1 lb.

Hercules Rheostat

The simplest and most effective means of testing the strength of a blasting machine without actually firing a series of electric blasting caps. Resistance based on electric blasting caps with 30 ft. copper wires. Can be used to calibrate galvanometers.

Electric Blasting Caps

For exploding charges of high explosives and blasting powder by means of electricity. Packed 25 or 50 to a carton, and 250 to 500 to a case, according to lengths of wires. Made in two strengths, No. 6 and No. 8. Furnished with copper wires, lengths 4 to 50 feet, and with iron wires 4, 6, and 8 ft.

Hercules Blasting Caps

For firing charges of explosives with fuse, made in strengths No. 6 and No. 8. Caps weaker than a No. 6 not recommended for high explosives. Packed 100 to tin box, and in cases containing 500, 1000, 2000 and 5000.

Miner's Squibs

For firing charges of Blasting Powder. Our special "Gas" Squib burns with ember instead of flame. Packed 100 to box, 10,000 to case.

Hercules Electric Squibs

Superior to the Miner's Squib because the Electric Squib can be placed in the center of a blasting powder charge. Enable firing several shots simultaneously with blasting machine and permit solid tamping. Made with copper or iron connecting wires.

"Ideal" Delay-Action Exploder

A combination electric igniter, fuse, and blasting cap, properly waterproofed, designed to fire charges in rotation by electricity. Made in No. 6 and No. 8 strengths, and 10 delay periods. Furnished with copper wires 4 to 20 feet, special lengths on request.

"Ideal" Delay Electric Igniter

Same as "Ideal" Delay-Action Exploders, but without blasting caps. Made in 10 periods of delay. Can be used to fire blasting powder charges in rotation. Cap can be crimped on igniter for firing high explosives.

Victor Delay Electric Blasting Caps

Recommended for same work as the "Ideal" Delay-Action Exploder, but furnished in only 1st and 2nd delays. Made with copper wires only. Can be used in same circuit with Hercules Electric blasting caps. Made in No. 6 strength only.

Victor Delay Electric Igniter

A waterproofed electric igniter with fuse and without blasting cap, for firing Blasting Powder charges electrically. Furnished in 1st to 6th delays with copper wires 4 to 20 ft. Cap can be crimped on end of fuse for firing high explosive charges.

"Star" Delay-Action Fuzes

A waterproofed electric igniter with fuse and without blasting cap, for firing Blasting Powder charges electrically. Furnished in 1st to 6th delays with copper wires 4 to 20 ft. Cap can be crimped on end of fuse for firing high explosive charges.

Copper Leading Wire

No. 14 B. & S. Gauge, lengths 200 to 500 feet on spool, single or duplex.

Copper Connecting Wire

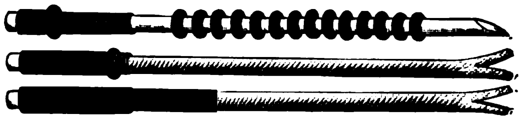
No. 20 B. & S. Gauge furnished on 1 lb. (210 ft.), or 2 lb. (420 ft.) spools.

Lead Spitters

For lighting fuse. Furnished on spools of 25 ft. each.

Hercules-Miller Cap Protectors

Made of pure rubber, 1¾″ and 2¾″ lengths, rolled on sticks, packed 100 small size and 60 large size to carton. Make joint waterproof and airtight between cap and fuse.

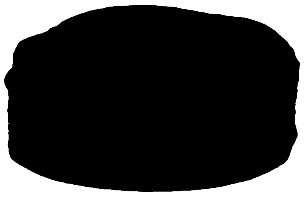


Kapseal

A plastic waterproofing composition for sealing cap and fuse joints.

Safety Fuse

We prepare a fuse for every condition of work. Packed in coils of 100 feet, wrapped in tough paper, and packed in cases containing 10 to 60 coils.



Hercules Thawing Kettles

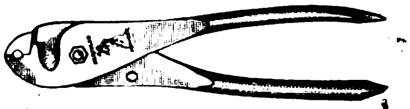
Consists of inner compartment surrounded by jacket for hot water, for thawing frozen dynamite.

Hercules No. 1, capacity 30 lbs. dynamite.
Hercules No. 2, capacity 60 lbs. dynamite.
Rundle dynamite thawer supplied on request.

Hercules Tamping Bags

Made in sizes 1″ x 8″ to 2″ x 18″, each bag approximately 2″ longer than specifications. Packed in bundles of 500 each, ten bundles to a bale.

Hercules Cap Crimpers



Combined cap crimpers and fuse cutters in any quantity.

G. R. McABEE POWDER & OIL CO.

General Office
PITTSBURGH, PA.

Eastern Sales Office
PHILADELPHIA, PA.

Distributing Points

TUNNELTON, PA.
HORRELL, PA.
WILSONBURG, W. VA.
WELCH, W. VA.
FOXCROFT, PA.
CATTLESBURG, KY.

Manufacturers of

Permissible Explosives, Dynamite, Black Blasting Powder, and Blasting Supplies

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We manufacture the following list of Permissible Explosives:

- Cronite No. 1
- Tunnelite AA
- Tunnelite B
- Tunnelite C
- Lomite No. 1
- Tunnelite No. 3
- Tunnelite No. 4
- Tunnelite No. 6
- Tunnelite No. 8
- Tunnelite No. 8 L.F.

The above Permissible Explosives are manufactured for use in gaseous and dusty coal mines, having passed all the tests of the Government Testing Station at Pittsburgh. We manufacture several different grades, suitable for all kinds of coal, where the best of results are desired.

"Cronite No. 1"

A permissible explosive for use in gaseous and dusty coal mines, practically fumeless and requires no thawing, an excellent permissible for hard shooting coal.

Tunnelite AA, B and C

These grades are considerable slower in action than Cronite No. 1, and should be used when good lump coal is desired, practically fumeless and requires no thawing.

Tunnelite 3-4, 6-8 and 8 L.F.

The above permissibles can be used very satisfactorily in dry or wet work, same gives off some smoke and fumes, but much less than Black Powder. These permissibles are adapted to all grades of coal, from hard shooting coal to soft coal. These permissibles will freeze and must be thawed before using.

Lomite No. 1

This permissible is a very quick explosive and can be used in wet or damp places with good results, and we recommend same strongly for shooting rock in the mines.

McAbee Dynamite

We manufacture all grades and strengths of Ammonia and Nitro-Glycerine Dynamite.

The McAbee Permissibles and Dynamite are manufactured with great care and under expert supervision. We manufacture nothing at our plant but Dynamite and Permissibles, so that we are in position to give our undivided attention to the manufacture of same. When quality is desired always order "McAbee" Dynamite or Permissibles, and you are then sure to obtain the best of results as we have experts in our employ experimenting with explosives all the time, in order to give our customers the very best.

Black Blasting Powder

Is made in seven Standard Granulations, from the best grade of materials, thoroughly incorporated, hard pressed, bright glaze and uniform quality and size.

Blasting Supplies

Include Blasting Machines, Electric Blasting Caps (Exploders), Caps, Fuse, Squibs, Leading and Connecting Wire, Magazines, in fact everything used with explosives.

ILLINOIS POWDER MFG. COMPANY

General Offices,
Pierce Building, Saint Louis.
Factory at Grafton, Illinois.
Makers of

"Black Diamond" Permissible

Manufactures also of
"Gold Medal" Dynamite, and Blasting Supplies

"Black Diamond" No. 2-A

A Nitro-Glycerin dynamite of medium velocity, best adapted to work where a fairly active powder is required. Especially recommended where vein of coal is firm or hard.

Put up usually, in 50 pound boxes of 1¼x8 inch sticks, 135 to 140 per box. Can also be furnished in larger sizes if desired.

"Black Diamond" No. 3-A

Slower than No. 2-A, but also a nitro-glycerin dynamite. Recommended where a large percentage of lump coal is wanted.

Put up in 1¼x8 inch sticks, in 50 pound boxes containing 135 to 140 sticks per box. Larger sizes furnished if desired.

"Black Diamond" No. 5

A high grade ammonia powder, very slow acting, and especially recommended where lump coal is wanted.

Made in 1¼x8 inch sticks usually, put up in 50 pound boxes containing 135 to 140 sticks per box. Larger sizes furnished if wanted.

"Black Diamond" No. 6 L. F.

A nitro-gylcerin dynamite much slower than No. 3-A and especially recommended where a large percent of lump coal is desired. Being low freezing, it can be used without thawing attention, at much lower temperatures than either No. 2-A or No. 3-A.

Put up in 1¼x8 inch sticks, 135 to 140 sticks to the 50 pound box. Larger sizes furnished if desired.

"Black Diamond" No. 7

A high grade ammonia dynamite of medium velocity, a little quicker than No. 5, and best used where a fairly active powder is needed, in hard or firm veins.

Put up in 1¼x8 inch sticks, 135 to 140 to the 50 pound box. Larger sizes if desired.

(This grade is also low freezing.)

Special "I. P. Mfg. Co." Sticks

The Illinois Powder Mfg. Co. originated a size of 1¾x6 inch sticks, each weighing one-half pound, and these have become very popular for certain uses. Packed usually in 50 pound boxes of 100 sticks each. All of the Company's brands may be had in this special size if ordered thus. Shipments are made of the 1¼x8 inch size, however, unless orders call for the newer size. Care should be taken to specify size in order to prevent delays or errors in filling requirements. Twenty-five pound boxes of the 1¾x6 inch size will be made up if requested.

No. 6-L F
BLACK DIAMOND
ILLINOIS POWDER MFG CO ST. LOUIS

Blasting Supplies

The Illinois Powder Mfg. Company carries a complete stock of Blasting Machines, Blasting Caps, Safety Fuse, Cordeau-Bickford Detonating Fuse, Electric Blasting Caps, Leading and Connecting Wire, Thawing Kettles, and all other Blasting Supplies. Every order is given careful and prompt attention. Your requirements are solicited.

THE KING POWDER COMPANY

CINCINNATI, OHIO
First National Bank Building

KING
POWDERS
TRADE MARK

Works, King's Mills, Ohio
Middletown Junction, Ohio

King Powder

Will give Results in increased tonnage and in percentage of Lump; it will meet every demand in the blasting line for which black powder is suitable.

We call to your attention our line of King Permissible.

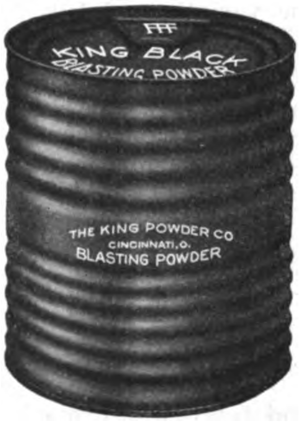
No. 2 A. Recommended where an active powder is required.

No. 3 A. Slower than No. 2 A; recommended where a large percentage of lump coal is required.

No. 6 L. F. Much slower than No. 3 A; low freezing and can be used at a lower temperature than Nos. 2 A and 3 A, without the necessity for thawing—recommended for large percentage of lump coal.

No. 5. Very slow acting—recommended where lump coal is desired.

No. 7. Quicker than No. 5—recommended where a fairly active powder is required and where the vein of coal is hard or firm.



Dynamite

A full line of various grades and strength; prompt shipment both from factory and local magazines.

A complete line of Blasting Supplies.

WRITE FOR SUGGESTIONS; THE SERVICES OF OUR EXPERTS ARE AT YOUR COMMAND

THE ENSIGN-BICKFORD CO.

SIMSBURY, CONN.

Manufacturers of

Safety Fuse For All Purposes
and
Cordeau-Bickford Detonating Fuse

We believe that it is of the utmost importance in the interest of both safety and economy to employ blasting supplies of high quality and only those best adapted to the particular conditions surround the work. We recommend for coal mining the following brands, which are briefly described to assist the purchaser in selecting a type to meet his requirements:

Beaver

A comparatively cheap fuse for use in dry or damp work. It has no tape, but is a cotton-countered fuse with a yellow finish.

Charter Oak

This fuse is similar in grade to Beaver. It is a white, double countered variety for use in wet work.

Single Tape

This is of about the same grade as Beaver but instead of the cotton winding threads, a tape is used, on which a gray finish is applied. It is for use in dry or damp work.

Double Tape

This is a better and more expensive fuse for use in wet work. It has two tape coverings which add strength as well as waterproof qualities.

Crescent; Anchor; Clover

These are all cotton-countered, white-finished fuses of high quality suitable for wet work.

In **extremely wet work** Anchor, Crescent or Clover Brands should be used.

If the work is to be done on the surface in cold weather, the countered fuses such as Beaver, Charter Oak, Crescent and Clover are best adapted in preference to a tape fuse, such as Single, Double or Triple.

Smoke: Clover Brand smokes less than any of the other brands of fuse.

All of our brands of fuse, excepting Clover and Charter Oak, have a standard burning speed of 90 seconds per yard when burned in the open, with an allowable variation of 10% either way from standard. Clover and Charter Oak have a standard burning speed of 120 seconds per yard when burned in the open, with an allowable variation of 10% either way from standard.

Fuse is put up in coils of 50 feet each, combined in one package containing 100 feet. It is packed in cases of the following sizes:

No. 0	500 ft.	No. 4	4,000 ft.
No. 1	1,000 ft.	No. 5	5,000 ft.
No. 2	2,000 ft.	No. 6	6,000 ft.
No. 3	3,000 ft.		

Price lists, sample cards and further information will be gladly furnished on application.

MINERS' SUPPLY CO.

SQUIBS

St. Clair, - Pa.

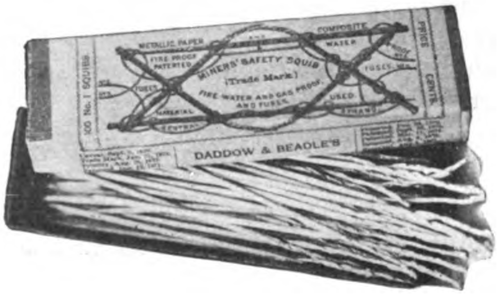
The Daddow & Beadle Patent Safety Squibs

for exploding black powder were originated and perfected by S. H. Daddow and Jesse Beadle. We have manufactured them for forty years, and they are established wherever mining is done as the safest, cheapest and most reliable means for exploding blasts in mines and quarries.

These squibs are packed in neat strong wooden cases, weighing about thirty pounds, easily stored and handled. They may be kept for years in a dry place without damage. A case holds 100 boxes, each containing 100 squibs—10,000 squibs to a case.

We call attention to this especially because since we originated and established this business other squibs have been offered on the market which in many cases are short count, varying from 100 to 80, or even less, to a box. Among these short-count squibs there are usually some that are unusable, without powder or with defective matches.

The D. & B. Squibs are honestly counted and rigidly inspected. Every squib we send out is reliable and effective, so far as care and attention can make it so.



No. 1 Squib

is for general use in mines where there is no dangerous quantity of inflammable gas. The match burns with a flame. These squibs are packed in boxes with yellow labels, and are known in the mines as "yellow label" or "sulphur" squibs.

No. 2 Squib

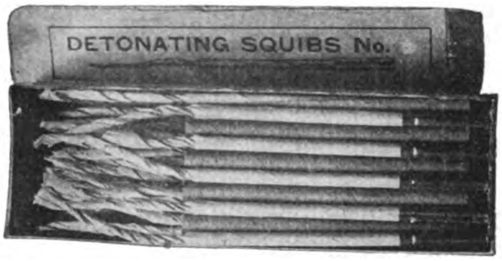
is similar to No. 1 described above, but is made specially for the deep pitching veins of the anthracite coal fields.

No. 3 Squibs

are intended for use in "fiery" or gaseous mines. The match burns with an ember which will not ignite gas. Touch paper is furnished for lighting the match. Boxes have red labels and the squibs are called by the names "gas" or "touch squibs".

Squibs for Exploding Dynamite and Permissible Powder

Nos. 1, 2 and 3 are for use with black powder. For use in exploding dynamite and "permissible powder" we offer our No. 6 Detonating Squib, made under patents of the Atlas Powder Company. This squib is complete in itself, ready to place in the needle hole as it comes from the box, and takes the place of blasting cap and fuse or electricity. It is simple, reliable, effective and is the cheapest method of firing charges requiring a detonator. These squibs are packed in cases weighing forty pounds. A case contains forty boxes of twenty-five squibs each—1,000 squibs to the case.



Nos. 1, 2, and 3 squibs are carried by all railroads as freight or express without restrictions.

Detonating Squibs are subject to same railroad regulations as blasting caps, but we can usually ship within two or three days from receipt of order.

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

MINE LIGHTING SECTION

The following manufacturers have catalogue descriptions in this section:

Concordia Safety Lamp Co.
Edison Storage Battery Co.
Edison Lamp Works.
Grier Bros. Co.
Harker Mfg. Co.
Hughes Brothers.
Justrite Mfg. Co.
Macbeth-Evans Glass Co.
Pioneer Electric Mine Lamp Co.
Simmons, John, Co.
Union Carbide Sales Co.
Westinghouse Lamp Co.
Witherbee Igniter Co.

For additional descriptions of Mine Lighting Equipment, not appearing in this section refer to Index of Products in front of book.

Edison Storage Battery Company

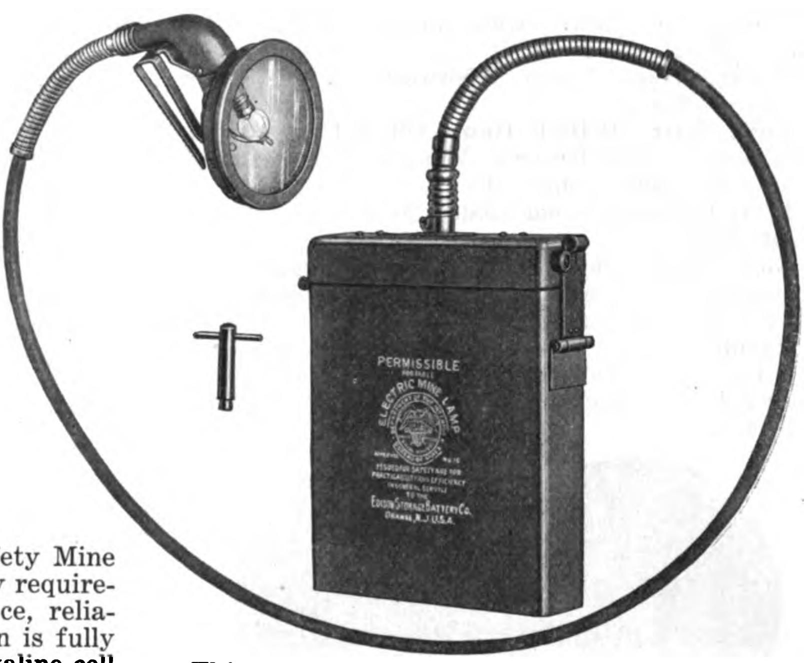
Factory and Main Office
232 LAKESIDE AVENUE, ORANGE, N. J.
Manufacturers of the

Edison Electric Safety Mine Lamp

of which over 90,000 are in daily use in the United States (7/19/17).

Distributors in
NEW YORK SAN FRANCISCO BOSTON LOS ANGELES CHICAGO SEATTLE DETROIT NEW ORLEANS PITTSBURGH

General Distributors
Mine Safety Appliances Co., Pittsburgh, Pa.



The Edison Mine Lamp is a **permissable** portable Electric mine lamp. It is the first to receive approval for Safety, Practicability and Efficiency under the provisions of Schedule 6-A.

The service that a storage battery must give in furnishing light to the miner's electric cap lamp is hardly equalled anywhere for exacting demands. Mining work is rough, and the portable storage battery that the miner carries gets more than its share of hard knocks. Not only must it withstand jars, bumps, dropping and other rough usage, but it also must contend with misuse and even deliberate abuse at the hands of careless miners. And at all times it must give constant, unfailing current to the cap lamp.

The record of the Edison Electric Safety Mine Lamp is one of unqualified success. Every requirement of strength, ruggedness, permanence, reliability and simplicity of care and operation is fully met by the famous Edison Nickel-Iron-Alkaline cell with its steel-and-iron construction.

Today there are more than 90,000 Edison Mine Lamps in use in the United States and Canada—more than the number of all other electric mine lamps combined. And every one of these lamps is still in service, giving good service.

In more than 1,000 mines throughout the United States and Canada, the Edison Mine Lamp is used to the practical exclusion of other electric mine lamps. The Edison has never been replaced by any other make of electric lamp. When it goes on the job, it goes on to stay. It is built with staying qualities.

This record of satisfactory service under all kinds of mining conditions, from the first day the Edison Mine Lamp was installed, tells better than many words of the superiority of this lamp.

The Edison is the only storage battery made with iron and steel in its composition or elements. It is the wonderful endurance and strength of this battery, with the permanence of its chemical reactions, that give it ability to stand up under actual mining conditions, day in and day out, year after year.

For full description and prices of the Edison Electric Safety Mine Lamp ask for Bulletin No. 300.

The Edison Shot Firing Battery

We manufacture a special shot firing equipment which is made to operate with the Standard Edison Mine Lamp Battery, thereby forming a simple, light-weight, strong and durable shot firing device.

This equipment is very rugged in construction and is so arranged that accidental making of contacts is impossible. The weight complete, as shown, is 66 ounces. A single charge of the battery is capable of firing a great many shots.

We supply the Shot Firing Top alone or with an Edison Mine Lamp Battery and case complete.

The Edison Mule or Trip Lamp

The use of Edison Batteries for Mule or Trip Lamps follows naturally from their wonderful success in cap lamp use.

The Mule or Trip Lamp has a special battery top to which the lamp is firmly fastened. A metal strap on back of battery case provides a means for fastening to the hames or to the mine car.

The battery of the Mule or Trip Lamp is the same as used in the standard Edison Electric Cap Lamps, and equipments are interchangeable.

We furnish the top only, which can be used with a regular Edison Cap Lamp Battery, or the lamp complete with an Edison Battery.

CONCORDIA SAFETY LAMP CO., Inc.

Main Office
420 Fulton Building, Pittsburgh, Pa., U. S. A.
Manufacturers of

"CEAG"
Electric Safety Mine Lamps

PATENTED MARCH 6, 1917

Awards

"Ceag" Cap Lamp, Approval No. 15, U. S. Bureau of Mines.

"Ceag" Hand Lamp, Approval No. 12, U. S. Bureau of Mines.

First Prize: British Home Office Competition, 1912, as the best Electric Miner's Safety Lamp, out of 197 lamps submitted.

First Prize and Gold Medal: World Exhibition, Ghent, 1913.

Gold Medal: Electric Mine Lamp, Lamp House and Accessories, Panama-Pacific International Exposition, San Francisco, 1915.

Collaborator's Silver Medal: In co-operation with the U. S. Bureau of Mines, in "The Mine" Panama-Pacific International Exposition, San Francisco, 1915.

More than 150,000 "Ceag" lamps in daily use all over the world.

Products

"Ceag" Electric Cap Lamp; "Ceag" Electric Hand Lamp; "Ceag" Electric Trip Lamp; Rescue Stations; Charging Equipment; Lamp Racks; Magnets; Complete Lamp Cabinets; Accessories for Charging Installations; Hand Voltmeters; Acid Filler; Acid Syphons; Densimeter; Celluloid Paper; Celluloid Paste.

"Ceag" Cap-Lamp
Mechanical Features

Reliable, simple in construction and durable.

Practically indestructible.

Absolutely explosion proof, even when lamp and glass are broken.

Accumulator capacity greater than any on the market (14 ampere hours).

Electrodes of long life and easily exchangeable.

Battery enclosed in a light, strong, cold-rolled sheet steel case, with acid and rust proof varnish.

Battery case equipped with magnetic lock.

No spilling of acid during operation.

Powerful, well distributed light, 100% more illuminating power for 14 hours than is required.

Fool-proof—will not burn unless properly assembled.

Contacts of spring type are easily accessible for cleaning.

All parts are easily accessible and can be removed and replaced in a moment.

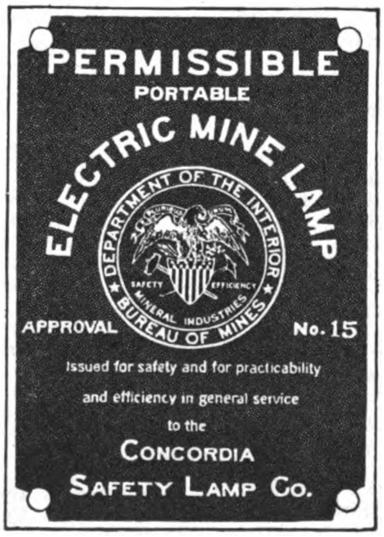
Low maintenance cost guaranteed.

The Head Piece

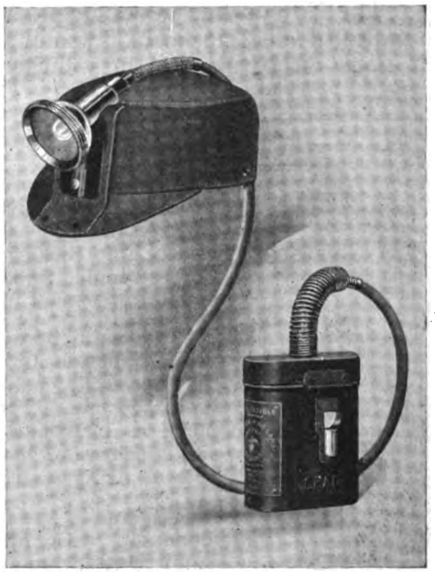
The lamp casing is made of a heavy brass cylinder, flared at one end to receive the lamp and reflector; at the other end the diameter is reduced and the casing partially flattened for the purpose of receiving the cable clamp and preventing it from turning. A shoulder at the extreme end insures cable and clamp against being pulled out.

The reflector is of the "Cleanezy" type designed to give a diffused and uniform distribution and arranged to throw the light at an angle of one hundred and thirty degrees. The surface does not easily collect dirt and if desired, can be cleaned easily by washing with soap.

In the center of the reflector is located the round tipless bulb, a National Mazda Lamp, rated at 1.95 volts and 0.85 ampere.



PERMISSIBLE
PORTABLE
ELECTRIC MINE LAMP
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
APPROVAL No. 15
Issued for safety and for practicability and efficiency in general service to the
CONCORDIA SAFETY LAMP CO.



WRITE FOR BULLETIN NO. 101.

The Safety Device

The safety device operates to open the lamp circuit when the bulb or glass, or both bulb and glass are broken. The bulb fits a flanged brass sleeve, which slides into a strong steel tubing. The bulb is pressed outward by a brass wire spring, carried by the sleeve. The lamp is held in the operative position against the pressure of the spring by means of the lens which touches the bulb and is held in place by the lens holder screwed upon the casing.

In case either glass lens of both lens and bulb are broken the spring device forces the lamp forward, thereby opening the circuit.

Battery

The battery is enclosed in a strong, cold-rolled sheet steel casing, copper oxidized and finished with an acid proof lacquer; the shape conforms with that of the battery, being flat with the ends rounded off. There being no sharp edges on the battery, it is easy and comfortable for the miner to carry on his body. Cover and casing are equipped with a suitable hinged locking device, and with a belt catch arrangement so that the battery casing can be easily attached to and removed from the miner's belt. In order to protect the battery from injury or from tampering by the miner, the casing is closed by means of a magnetic lock which can only be opened by means of a strong magnet installed in the lamp house.

The storage battery is a single-cell, 2-volt lead accumulator, encased in a heavy celluloid container, thus permitting at all times easy inspection of the condition of the electrodes and of the acid. The battery-vessel and the lid are held together by means of celluloid paper pasted across the two, thus allowing very convenient and easy handling of the batteries, if after 250-300 shifts, replacement of electrodes is desired. The electrodes are easily and most cheaply exchangeable. By means of an ingenious arrangement the gas cannot be spilled, but gas developing while charging the battery can easily escape.

The cells are rendered unspillable by means of this design, and no acid at all can spill, no matter in what position the battery is held or operated during the actual shift or in the lamp house. This has been proven repeatedly in tests made by the U. S. Bureau of Mines.

The Cable Cord

The Cap-Lamp Outfit is equipped with a special cable cord of exceedingly high durability. The outside diameter is 3/8-inch. The conductors are twisted together with a very short lay, thus providing the necessary flexibility. The whole cord is covered with a layer of high-grade rubber compound to prevent the access of water to the cotton insulated conductors. Where the cable emerges from the casing, it is protected by a helical spring, which extends far enough from the casing to avoid the possibility of sharp bends being made in the cable. At its other end the spring is provided with a brass bushing, which has its inner surface rounded off at its outer end in order to reduce the wear on the cable. Where the cable enters the battery metallic link armor is provided, the end of which is also shut off by a brass bushing. An additional spring of strong piano wire is screwed upon the extension piece of the battery casing. This spring envelops the armature for about three-fourths of the length, protects it against strain, and prevents workmen from tampering with the joints.

Lead Batteries

The development of Electric Safety Lamps with lead batteries has been going on for more than thirty-five years and has resulted in such a high state of perfection that so far no other type of lamp has surpassed or even equalled it. The development of lamps with alkaline batteries is of comparatively recent date. While they are admittedly promising, yet despite the claims made by the manufacturers, it is a fact that alkaline batteries, whatever their merits in general service may be, in connection with electric safety lamps are in quite a number of points inferior to lamps with lead batteries. For instance:

Only one lead cell is required per lamp, whereas two for the alkaline type are necessary.

The discharge voltage of the lead cell is practically constant, whereas that of the two alkaline cells is subject to a large fluctuation resulting in over voltage at the bulb terminals at the beginning of the shift, in order to have sufficient light at the end, causing a decrease of fifty percent in the life of the bulb.

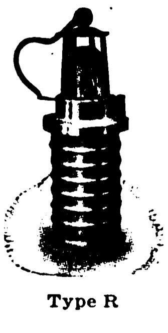
In addition, it remains to be seen whether the accessibility of the lead battery with exchangeable electrodes, which permits relatively unskilled tenders easily to exchange and repair the electrodes is not preferable to the impossibility of repairing the alkaline cells in the lamp house.

Besides this it is to be expected that the influence of the damp air and acid containing water in the pit will prevent the proper working of the gas vent of the cell during recharging to such an extent that explosion of the cells may occur.

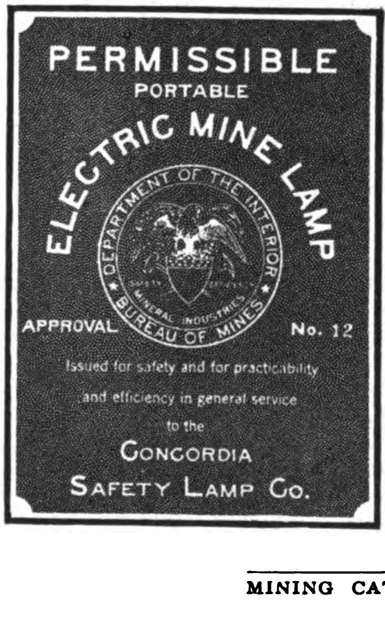
And as a logical outcome it is safe to assume that the already poor efficiency of the alkaline cell will be lowered still more and become an important factor in mine lamp operations. The efficiency of the lead cell ranges from 80 to 85 percent, whereas the alkaline cell is not more than 60 to 65 percent efficient. Hence the alkaline cell requires one-third more electrical energy than the lead cell, increasing the total cost in the same ratio.

"Ceag" Hand Lamp

Both hand lamps and cap lamps have their place in the mine, and the simple rule is about to be recognized and followed in actual practice, to adopt mixed equipment of hand and cap lamps, if increased output of coal is given first consideration.



Type R



PERMISSIBLE
PORTABLE
ELECTRIC MINE LAMP
APPROVAL No. 12
Issued for safety and for practicability and efficiency in general service to the
CONCORDIA SAFETY LAMP CO.

DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
MINERAL INDUSTRIES

Type RS.

PIONEER ELECTRIC MINE LAMP CO.

Originators of the Miners Electric Cap Lamp

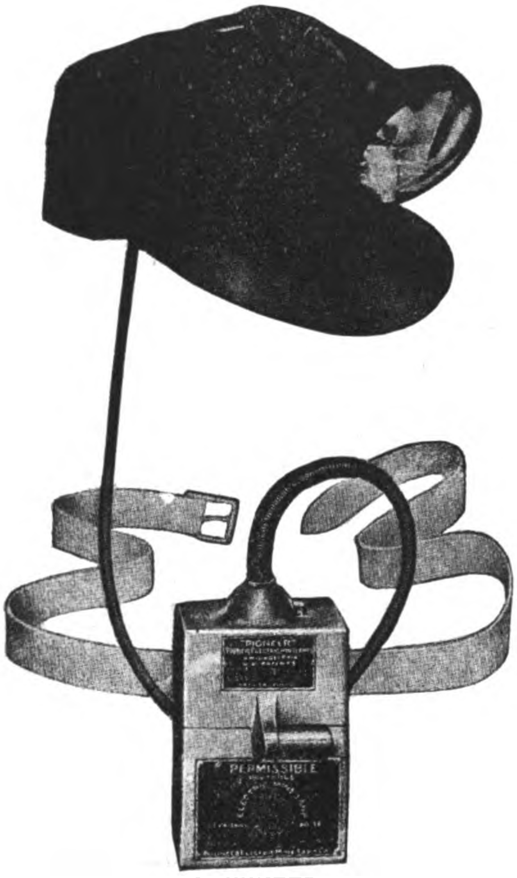
2545 N. Broad Street, Philadelphia, Pa.

Manufacturers

Pioneer Electric Safety Lamps

Approved by U. S. Bureau of Mines

Under Schedule 6A



PATENTED

Twelve Hours Bright Light.
Non-Spilling Storage Battery.
Light Weight.
Strong, Rugged and Fool Proof.
Strongest and Most Powerful Portable Storage Battery.
Guaranteed.
Maintained at Little Cost.

Every lamp outfit bears this approval plate of the U. S. Bureau of Mines, issued for safety and for practicability and efficiency in general service.

Successful Safety—Buy It for Your Men in Pioneer Lamps

The leading authorities join us placing their stamp of approval on the Pioneer Permissible Mine Safety Lamp. For a great number of reasons. Some of which are:

That the Pioneer lamp gives 50 to 60% more light than ordinary lamps.

That it has a long-lived bulb—guaranteed for 300 running hours.

That it is built to withstand the severest sort of abuse—which it is quite liable to be subjected to.

And its battery is not only light and not subject to buckling—but is amply protected by a heavy cast aluminum case. Then the battery may be charged over night—at a very slight expense.

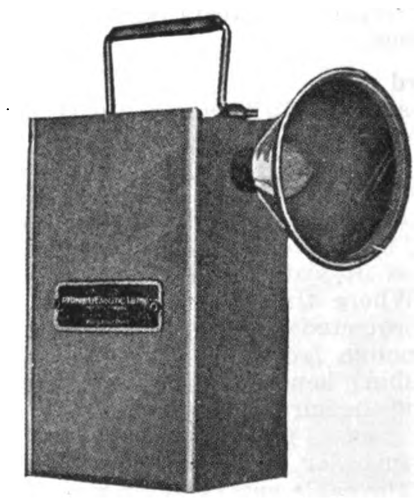
And finally the cost of operating Pioneer lamps has proved to be less than carbide or even oil lamps.

We want you to know more about Pioneer Lamps—write us for prices, etc.

Patents

March 13, 1906; March 11, 1913; October 14, 1913; May 19, 1914; May 19, 1914; December 15, 1914. Other patents pending.

Pioneer Electric Safety Hand Lantern for Watchmen, Etc.



No. 76—Electric Safety Hand Lamp.

"Approved by the National Board of Fire Underwriters."

Storage battery easily recharged.

WITHERBEE IGNITER COMPANY

Main Office and Factory, Springfield, Mass.,

Manufacturers of

WICO SAFETY ELECTRIC MINE LAMPS

The Wico Equipment Co.
E. O. Alston
Oliver Bldg., Pittsburgh, Pa.
General Sales Agents

J. J. Ramsey, Pittsburgh.
T. R. Jones, Denver, Colorado
Rivenburg-Blackwood Co., Scranton, Pa.

A careful comparison of records of electric safety mine lamps reveals this important message we convey to prospective purchasers, and of this you can be certain:

No safer, no more dependable, no more economical electric mine lamp ever went into a mine.

Circular 6-A, Bureau of Mines specifies 33⅓% economy in bulbs for lead batteries.

Wico new cord tests more than 50% above the next best.

The Wico lamp has the lowest cost per hour of light, whether it be operated for one year or many years. In fact the life of our outfit is indeterminable because it pays to renew those parts which have rendered full service.

Wico aluminum case is stouter than steel.

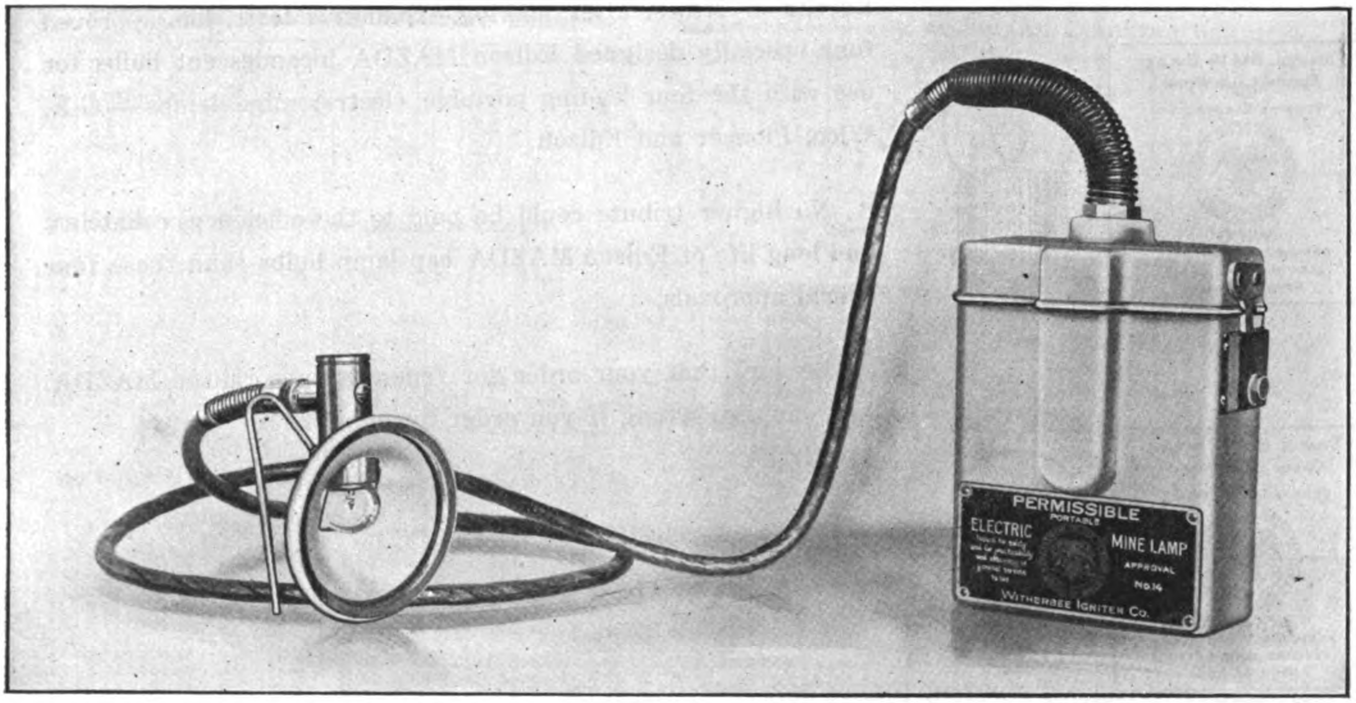
Some of the largest operators who bought Wico lamps in 1913 and 1914, and subsequently tried them all, are buying Wico lamps in 1917.

The Wico guarantees to you every credit allowed by any insurance company for safety electric lamps.

The Wico is approved by the U. S. Bureau of Mines and that approval means just what it says: "For safety and for practicability and efficiency."

Our guarantee is sensible, ample and worthy of your confidence.

Permit our representative to explain our proposition.



EDISON LAMP WORKS

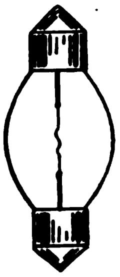
OF GENERAL ELECTRIC COMPANY

GENERAL OFFICES
HARRISON, N. J.

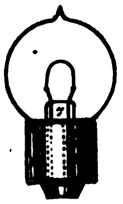
SALES OFFICES
IN PRINCIPAL CITIES

Edison MAZDA Lamp Bulbs for Electric Cap Lamps

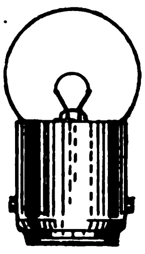
SYMBOL BM 13 BULBS
EDISON LAMP WORKS
OF
GENERAL ELECTRIC CO.
APPROVED FOR USE WITH THE
GENERAL ELECTRIC
PERMISSIBLE PORTABLE
ELECTRIC MINE LAMP
APPROVAL NO.13



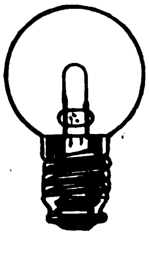
SYMBOL BM 10 BULBS
EDISON LAMP WORKS
OF
GENERAL ELECTRIC CO.
APPROVED FOR USE WITH THE
EDISON
PERMISSIBLE PORTABLE
ELECTRIC MINE LAMP
APPROVAL NO.10



SYMBOL BM 14 BULBS
EDISON LAMP WORKS
OF
GENERAL ELECTRIC CO.
APPROVED FOR USE WITH THE
WICO
PERMISSIBLE PORTABLE
ELECTRIC MINE LAMP
APPROVAL NO. 14



SYMBOL BM 16 BULBS
EDISON LAMP WORKS
OF
GENERAL ELECTRIC CO.
APPROVED FOR USE WITH THE
PIONEER
PERMISSIBLE PORTABLE
ELECTRIC MINE LAMP
APPROVAL NO.16



On page five of Technical Paper 75, issued by the U. S. Bureau of Mines, this statement appears:

> "The reason why the Bureau of Mines advocates the use of portable electric lamps in mines is because fire and explosion hazards will be decreased thereby."

The Bureau of Mines says—
EDISON MAZDA

Realizing that no cap lamp is better than its bulb, the U. S. Bureau of Mines, after making exhaustive tests, has approved four specially designed Edison MAZDA incandescent bulbs for use with the four leading portable electric mine lamps — G-E, Wico, Pioneer and Edison.

No higher tribute could be paid to the efficiency, reliability and long life of Edison MAZDA cap lamp bulbs than these four official approvals.

Be sure that your order for renewals says Edison MAZDA. You can't go wrong if you order by name.

WESTINGHOUSE LAMP COMPANY

165 Broadway, New York, N. Y.

Atlanta
Baltimore
Boston
Buffalo
Butte
Chicago

Cincinnati
Cleveland
Columbus
*Dallas
Denver
Detroit

*Westinghouse Lamp Corp'n.

Kansas City
Los Angeles
Milwaukee
New Orleans
New York
Philadelphia

Pittsburgh
Portland
St. Louis
Salt Lake City
San Francisco
Seattle
Syracuse

GUARANTEED BY THE NAME

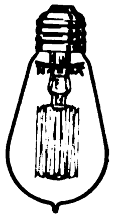
For Canada, Canadian Westinghouse Co., Ltd., Hamilton, Ont.

MANUFACTURERS OF ALL TYPES AND SIZES OF INCANDESCENT LAMPS FOR MINE LIGHTING

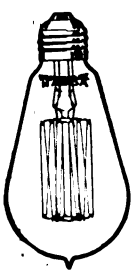
Every mine has its peculiar lighting problem. Therefore the Westinghouse Lamp Company maintains a lighting service department to assist you in securing the best results from your lighting equipment. This service is at your disposal at any time without charge.

The cheapest lamp is not always the most economical. Many mines are still using carbon lamps. By the substitution of the modern high efficiency Mazda lamp you can increase your lighting for the same amount of electrical energy to three times that of carbon lamps.

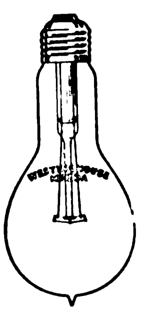
What you really pay for is candlepower, and it will be profitable for you to investigate and see whether you are buying illumination, or just lamps.



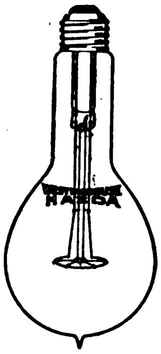
10, 15, 20 Watt Mazda B



60 Watt Mazda B



75 Watt Mazda C



100 Watt Mazda C

MAZDA LAMPS FOR STANDARD LIGHTING SERVICE

Size of Lamp in Watts	Lumens per Watt	Watts per Spherical C-P.	Type and Size Bulb	Diam. Bulb, Inches	Max. Over All Length, Inches	Base Regularly Supplied	Stand. Pkg. Quantity	List Price Clear	List Price Frosted
110 to 125 Volt Straight Side (Mazda B Lamps)									
10	7.52	1.67	S-17	2⅛	4⅝	Med. screw	100	$0.27	$0.30
15	8.55	1.47							
25	9.17	1.37	S-19	2⅜	5¼	Med. screw	100	.27	.30
40	9.45	1.33							
50	9.52	1.32	S-19	2⅜	5¼	Med. screw	100	.27	.30
60	9.74	1.29	S-21	2⅝	5½	Med screw	100	.36	.40
100	10.13	1.24	S-30	3¾	7⅞	Med. sc. sk.	24	.65	.72
110 to 125 Volt Pear-Shape (Mazda C Lamps)†									
75	11.53	1.09	PS-22	2¾	6⅛	Med. screw	50	$0.65	$0.70
100	12.57	1.00	PS-25	3⅛	7⅛	Med. screw	24	1.00	1.05
150	13.66	0.92	PS-25	3⅛	7⅛	Med. screw	24	1.50	1.55
200	14.61	0.86	PS-30	3¾	8⅝	Med. screw	24	2.00	2.07
300	16.11	0.78	PS-35	4⅜	9¾	‡Mog. screw	24	3.00	3.10
400	15.32	0.82	PS-40	5	10	Mog. screw	12	4.00	4.15
500	16.11	0.78	PS-40	5	10	Mog. screw	12	4.50	4.65
750	16.98	0.74	PS-52	6½	13⅜	Mog. screw	8	6.00	6.25
1000	17.95	0.70	PS-52	6½	13⅜	Mog. screw	8	7.00	7.25

MAZDA LAMPS FOR STANDARD LIGHTING SERVICE

Size of Lamp in Watts	Lumens per Watt	Watts per Spherical C-P.	Type and Size Bulb	Diam. Bulb, Inches	Max. Over All Length, Inches	Base Regularly Supplied	Stand. Pkg. Quantity	List Price Clear	List Price Frosted
220 to 250 Volt Straight Side (Mazda B Lamps)									
25	7.62	1.65	S-19	2⅜	5¼	Med. screw	100	$0.33	$0.36
50	8.43	1.49	S-19	2⅜	5¼	Med. screw	100	.33	.36
100	9.04	1.39	S-30	3¾	7⅞	Med. sc. sk.	24	.80	.87
150	9.45	1.33	S-35	4⅜	8¾	Med. sc. sk.	24	1.20	1.30
250	10.47	1.20	S-40	5	10	Med. sc. sk.	12	2.00	2.15
220 to 250 Volt Pear-Shape (Mazda C Lamps)†									
200	12.57	1.00	PS-30	3¾	8⅝	Med. screw	24	$2.20	$2.27
300	13.66	0.92	PS-35	4⅜	9¾	Mog. screw	24	3.60	3.70
400	14.61	0.86	PS-40	5	10	Mog. screw	12	4.80	4.95
500	14.78	0.85	PS-40	5	10	Mog. screw	12	5.40	5.55
750	15.32	0.82	PS-52	6½	13⅜	Mog. screw	8	7.20	7.45
1000	16.11	0.78	PS-52	6½	13⅜	Mog. screw	8	8.40	8.65

HUGHES BROTHERS

420 North Main Avenue SCRANTON, PA.

Manufacturers of all Types of

Miners' Safety Lamps

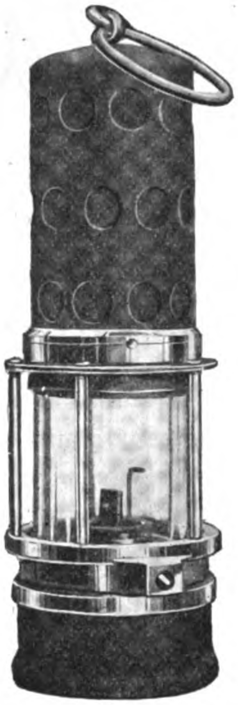
Products.

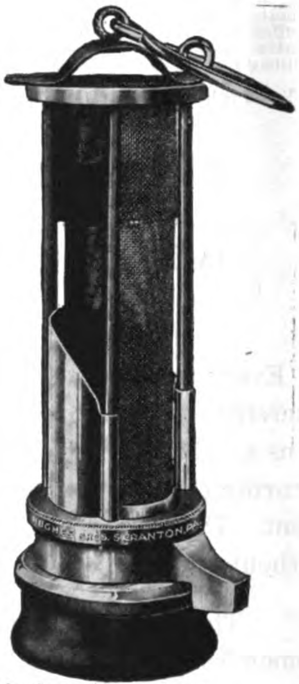
Miners' Safety Lamps and Supplies of all kinds.

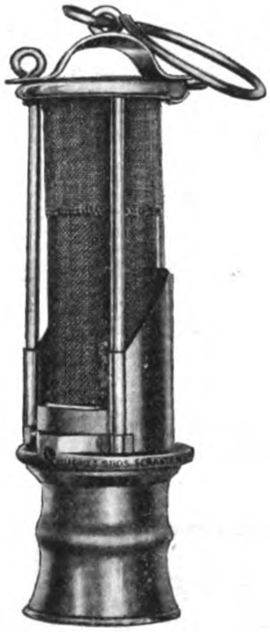
General.

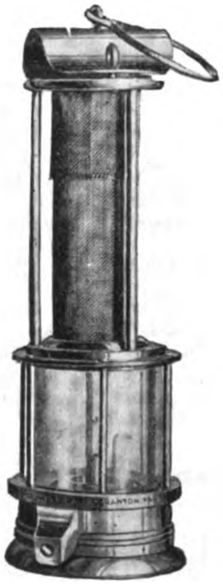
Safety first. You have every assurnace that safety is first when using these lamps which have stood the test of Quality, Strength and Durability for over fifty years.

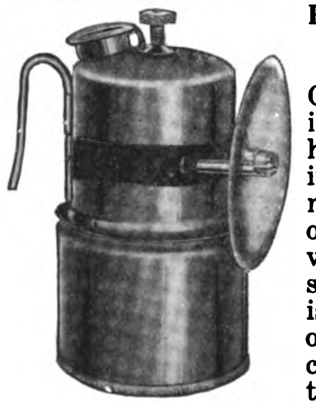
For complete line of lamps send for catalogue.





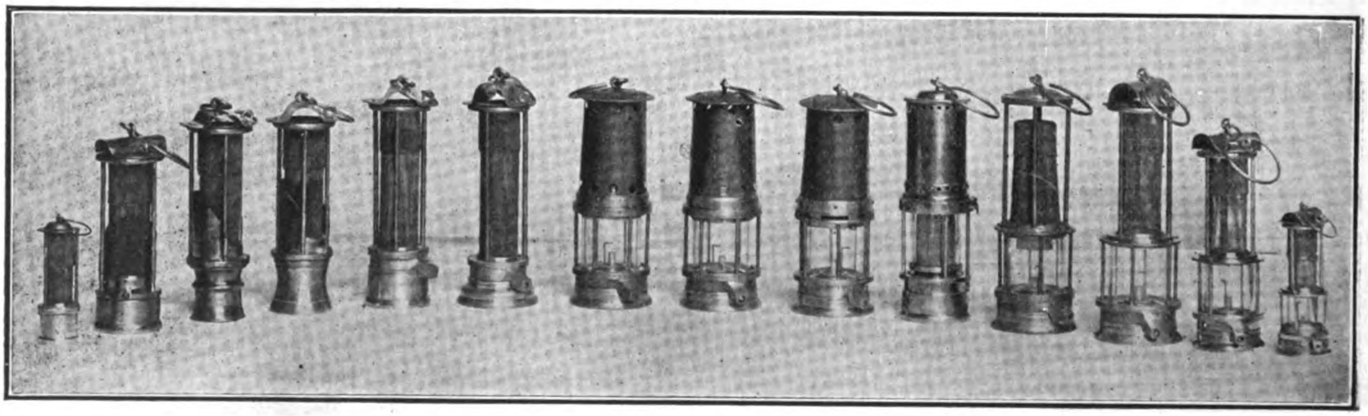






Pathfinder Acetylene Lamps.

The Lamp shown is our Cap or Head Lamp. It is constructed from extra heavy sheet brass, drawn into solid shells. There are no seams or joints on the outside to cause leaks. The valve seat is also a drawn shell, and the needle valve is made from a solid piece of rod, in such a way that it conducts the water to bottom of carbide chamber, without any possibility of choking off the water supply. Our claims for these lamps are that they are the strongest upon the market, and will burn more steadily. One extra chamber furnished with each lamp.



MACBETH-EVANS GLASS COMPANY

Pittsburgh, Pa.

Branch Offices

New York............143 Madison Avenue
Chicago.............172 West Lake Street
Philadelphia.........1613 Chestnut Street
Boston....................30 Oliver Street
St. Louis.........Laclede Gas Light Bldg.
San Francisco................Rialto Bldg.
Cincinnati................Pickering Bldg.
Cleveland...............1900 Euclid Bldg.
Dallas...............1812 Live Oak Street
Macbeth-Evans Glass Company, Ltd...................160 Bay Street, Toronto, Canada

Macbeth "High Speed" Glasses for Miners Safety Lamps

These glasses are the most heat-resisting ever made. They stand the tests of the U. S. Bureau of Mines and the British Home Office and have been subjected to tests even more severe.

They may be put into boiling water, left there to become thoroughly heated to 212°, then immediately plunged into ice water. For flame test, a flame can be directed indefinitely against the sides of the glass without breaking.

These tests are very simple and can easily be made.

Macbeth "High-Speed" glasses have been adopted as standard by many well-known companies.

Coal mining companies report that breakage has been cut down more than fifty per cent. Any breakage which has occurred has been entirely due to such accidents as striking the glass (not the lamp) against sharp edges of rock, or being struck by miners' implements.

In the very rare cases of this glass breaking the broken piece does not fall out, but stays in place — thus retaining the safety feature of the lamp.

Flame Test

Flame can play indefinitely against sides of glass without breaking it.

Macbeth "High-Speed" glasses are made for all standard makes of safety lamps.

Colored glasses (red, green, yellow or blue, or Alba, white, a diffusing glass) are also made.

"High-Speed" is a very economical form of insurance, reducing accidents, with all their frightful results and heavy costs, to the minimum.

It is also the cheapest way to buy glasses— not per piece, but by the year. The breakage is so small.

Write for further information and prices.

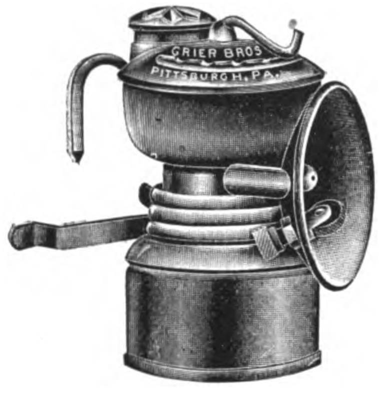
THE GRIER BROTHERS COMPANY

ESTABLISHED 1839.

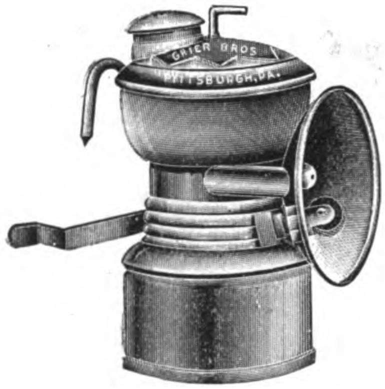
PITTSBURGH, PA.

Manufacturers of

Carbide Lamps, Tinware and Miner's Supplies



No. 95, Polished Brass.
No. 105, Polished Nickel.
Dia. of Reflector, 2¼ Inches.



No. 92, Polished Brass.
No. 102, Polished Nickel.
Without Valve Feed.
Dia. of Reflector, 2¼ Inches.

After several years experimental work, we announce that we now have the **best line of Miners' Carbide Lamps Manufactured.**

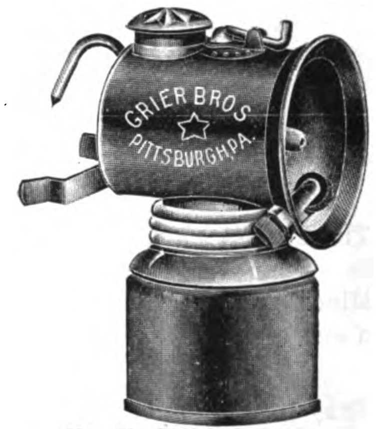
We exercise the **greatest care**, both in **workmanship and material.** Every lamp is thoroughly tested before leaving our factory. If one proves defective we willingly replace it.

The valve lamp has proven the most popular among the miners. Our valve puts the water just where it is needed.

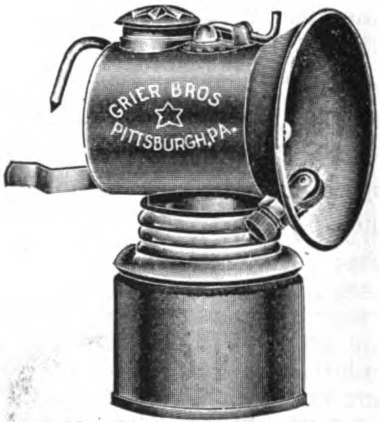
There are no parts to wear out.

Water can not leak from the filler cap as in the old lamps.

Note the reinforcement in tops of Numbers 95 and 92, also reinforced reflectors on all lamps. Reflectors can not be knocked off.



No. 79, Polished Brass.
No. 69, Polished Nickel.
Dia. of Reflector, 2¼ Inches.



No. 77, Polished Brass.
No. 68, Polished Nickel.
Dia. of Reflector, 2½ Inches.

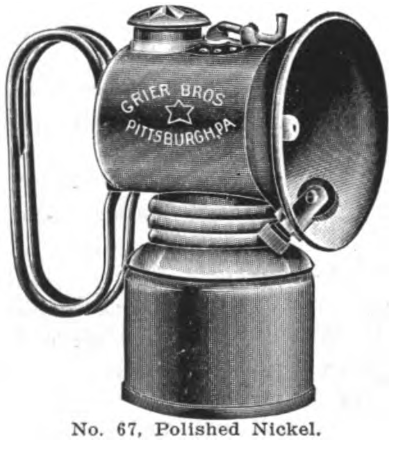
Why Grier Lamps Are Superior

No parts to wear out.

No overflow from filler caps.

No valve trouble.

No trouble in removing carbide chambers from lamps. We put three finger grips on each chamber, this gives the miner a chance to unscrew the chamber no matter how tight it becomes.



No. 67, Polished Nickel.

Every place the Grier lamps have been tried they have given perfect satisfaction. A trial is all we ask to convince you.

We were the first to put the lighter on carbide lamps.

Write for catalog.

HARKER MANUFACTURING CO.

CINCINNATI, OHIO.

Manufacturers of

"Brite-Lite Improved Miner's Carbide Lamps

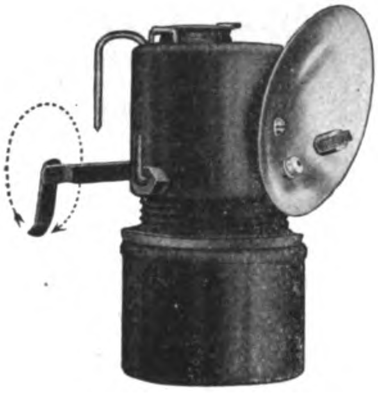
The perfect miner's light--A different carbide light

Products

"Brite-Lite" Carbide Miners Lamps.

"Queen" 3-gallon type soda and acid fire extinguishers.

Safety-first dry powder extinguishers.



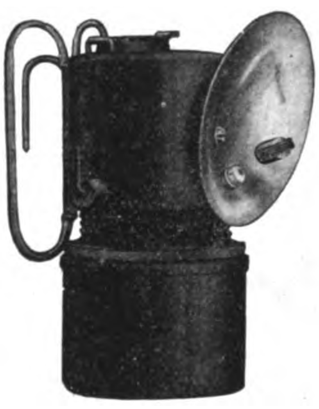
Patented
Type M—Miners' Cap Lamp.
Extremely Light in Weight.
Candle Power 17.

"Queen" Swinging hose racks.

"Queen" safety gasoline cans.

The "BRITE-LITE" Lamps are made in three types. Two sizes for each type. One has a burning capacity of 3 hours, the other 4 hours.

The greatest difficulty in the practical operation of the carbide miner's lamp has always been the tendency for the water and gas feed to stop or clog up. This was a serious objection for the reason that it gave no end of trouble and annoyance to the miner, because he was continuously obliged to stop his work (thereby losing time) and adjust his lamp to keep it burning with anything like a fairly large flame. **After years of experimenting we have designed the "Brite-Lite".** In this new lamp, we have overcome all of these objectionable features, thereby eliminating this annoyance and loss of time, and we will guarantee the **"Brite-Lite"** to burn its full capacity with a steady white flame, and without the usual jiggling and punching or knocking to keep it burning.



Patented
Type F—Foreman Lamp.
Candle Power 17.

Water Feed

This s the patent feature on **"Brite-Lite"** Lamps, and is the most perfect water feed yet produced. The principle of the **"Brite-Lite"** water feed is extremely simple, at the same time very effective, and with our feeding system, it is almost impossible for the gas to escape through the water container. This eliminates the objection of water bubbling through the water cap and running down the outside of the lamp. The **"Brite-Lite"** water feed is regulated with a lever at the side of the lamp in place of at the top, and operates with an eccentric motion which places the flow of water under full control of the operator at all times, which permits him to secure a steady flame at all times. The **"Brite-Lite"** water feed being a gravity over-flow system, it is almost impossible for it to clog, and at the same time places the water in the carbide so that all of the carbide is slacked as used, thereby using less carbide than other makes of lamps. It is of a very strong construction, all parts being interchangeable, and if by accident any part should be broken, it can easily be replaced.

WATER CANNOT DRIP OUT OF TOP AND RUN DOWN YOUR FACE AS ALL LAMPS WITH WATER FEED CONTROL AT TOP WILL DO.

Gas Feed

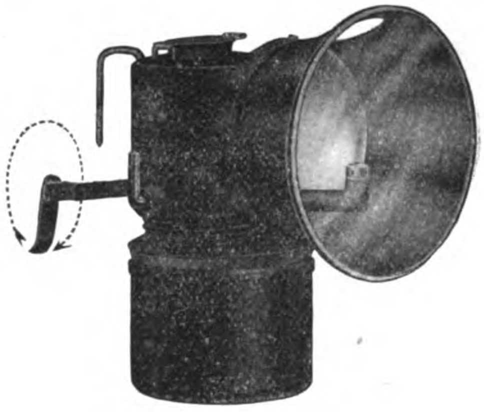
The burner tube on **"Brite-Lite"** Lamps is direct from the carbide container. It is only ½ inch long, and is perfectly straight. With this construction, you can easily remove the burner tip with a nail or wire. With other makes it is necessary to use pinchers to remove the burner tip.

Reflector

Is easily removed, being fastened to the lamp with a small screw. It is nickel plated or polished brass as required, and is readily cleaned.

Self-Lighting

The **"Brite-Lite"** has a positive self-lighting mechanism attached to reflector.



Patented
Type D—Driver or Motorman Lamp.
Candle Power 17.

JUSTRITE MANUFACTURING CO.

CHICAGO, ILL.
Manufacturers of
Justrite Carbide Mine Lamps
for
Miners, Superintendents, Engineers, Drivers, Pit-Bosses, Etc.

Justrite
TRADE MARK

Products

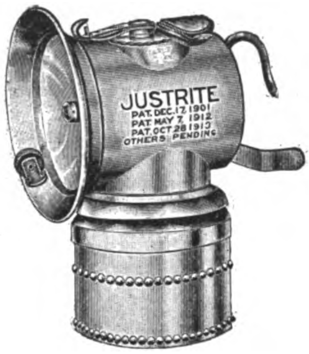
Justrite Carbide Lamps are made in many sizes and different styles. There is a suitable lamp for every mining purpose. The models illustrated below are the most desirable for coal miners and are known as Cap or Pit Lamps. All lamps are equipped with Self-Lighter attachment.

Lever Feed—Valve Control

2¼-inch Reflector.

POLISHED BRASS
No. 85 with Carbide Can.
No. 57 with Extra Bottom.
No. 407 Lamp Only.

2⅝-inch Reflector.



POLISHED BRASS
No. 258 with Carbide Can.
No. 268 with Extra Bottom.
No. 427 Lamp Only.

Weight
5
Ounces

Candle
16.7
Power

The Lever Water Feed

consists of a valve enclosed in a ¼-inch tube, so constructed that it increases or decreases the supply of water, enabling the user to burn the flame at any size desired. The valve is operated by a lever sliding back and forth over notches, and held firmly in place by a small spring.

Spiral Feed—Valve Control

2¼-inch Reflector.

POLISHED BRASS
No. 124 with Carbide Can.
No. 121 with Extra Bottom.
No. 527 Lamp Only.

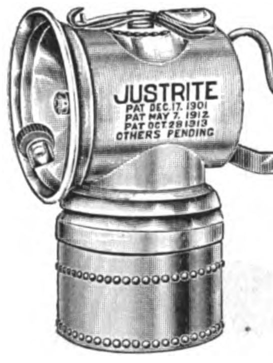
2⅝-inch Reflector.

POLISHED BRASS
No. 154 with Carbide Can.
No. 151 with Extra Bottom.
No. 547 Lamp Only.

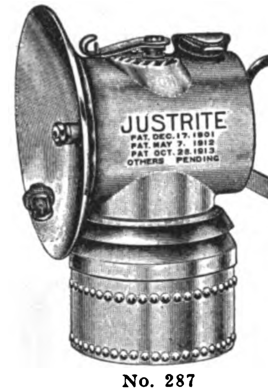
The Spiral Water Feed

The new Spiral Valve Stem prevents clogging in the water tube. It fits snugly and forces the water to travel around the Spiral a distance of 7 inches while in other lamps it travels in a straight course only 1¼ inches. This increases the gas resistance about six times, which prevents waste of gas and produces an even, steady burning flame.

LAMPS WITH "JIFFY" CONTAINERS AND DUPLEX VALVE FEED.

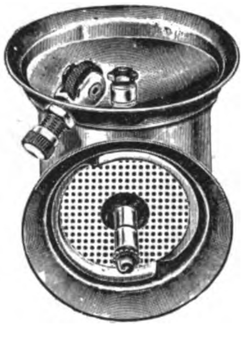


No. 227



No. 287

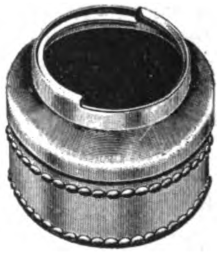
No. 227. Polished Brass, Lamp Only.
No. 287. Polished Brass, Lamp Only.



Description and Parts

"JIFFY" CONTAINER

Showing the Helix Locking Device
—
Pat. applied for



The "JIFFY" CONTAINER with **Helix** lock is a wonderful improvement over the rolled screw threaded bottom with which other Carbide Lamps are equipped. It will not corrode or stick. The **Helix** locking device has two-thirds less bearing surface—reduces the friction and eliminates the grinding, sticking feature of screw threads. It locks tight with a slight turn, and is so named because it can be put on and taken off in a "JIFFY." It is stronger and will stand more hard usage than the screw threaded bottom because it is made of heavier brass with doubled-over edge. The used carbide can be emptied quicker and easier because the neck is shorter and opening larger.

The Lever Duplex Feed has two valves. The upper valve regulates and shuts off the water flow; the lower valve acts as a check and prevents over generation.

Largest Manufacturers of Carbide Lamps. Catalog On Request.

JOHN SIMMONS COMPANY

San Fransisco, Cal. NEW YORK Montreal, Can.

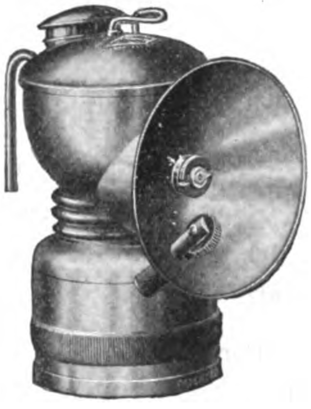
Manufacturers

Pioneer Carbide Lamps for Mine Use

No. 125

Hold-A-Lite

No. 130



No. 132

No. 125—Bottom valve feed—Weight, 5½ ounces; Height, 4 inches. Burns 3 hours on one charge. Notches on top of lamp holds lever in position. Lamp equipped with spark lighter.
Price, complete $1.25

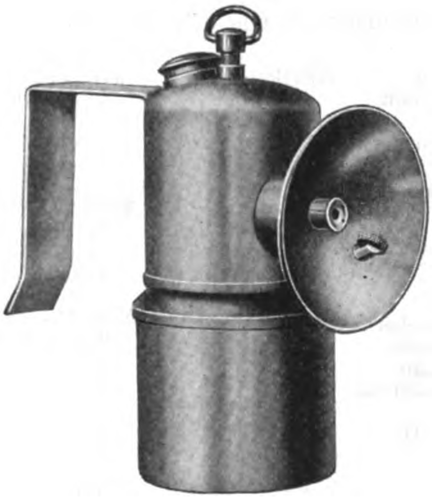
Hold-A-Lite—Bottom valve feed—Weight, 5⅞ ounces; Height, 3¾ inches. Burns 2½ hours on one charge. Notches on top of lamp holds lever in position. This lamp equipped with spark lighter, wind shield and carbide container.
Price, complete $1.25

No. 130—Automatic water feed—Weight, 5½ ounces; Height, 4 inches. Burns 3 hours on one charge. This lamp operates similar to the No. 132 but is equipped with a water shut-off. The valve on this lamp is constructed so that the light is not effected by the swing of the miners head as are other lever feed valve lamps. Price, complete.$1.25

No. 132—Automatic water feed—Weight, 5 ounces; Height, 4 inches. Burns 3 hours on one charge. The No. 132 is fitted with the patented Automatic Water Feed. The automatic regulation of the water makes hand regulation unnecessary. Lamp equipped with spark lighter.
Price, complete $1.25

No. 160 Float Feed.

No. 160—For Superintendents use—Operates with our new float feed. This lamp requires no attention during the entire life of the charge and will maintain an even steady flame. Burns 6 hours on one charge. Equipped with wind shield.
Price, each $2.50



No. 204 Float Feed.

No. 204—Trip Lamp—Handle just fits over rear of car and holds lamp rigid. Equipped with a wind shield so cannot be blown out. Acts as a warning to track walkers. Burns 12 hours on a charge.
Price, each $3.75

All Lamps Fitted with Lava Burners, Rigid Removable Reflector and Spark Lighter.

We can furnish any of these lamps either with or without the wind shield or shot-proof feature and with various equipment such as hooks, reflectors, extra containers or ½ lb. carbide can.

UNION CARBIDE SALES COMPANY

NEW YORK
30 East 42nd St.

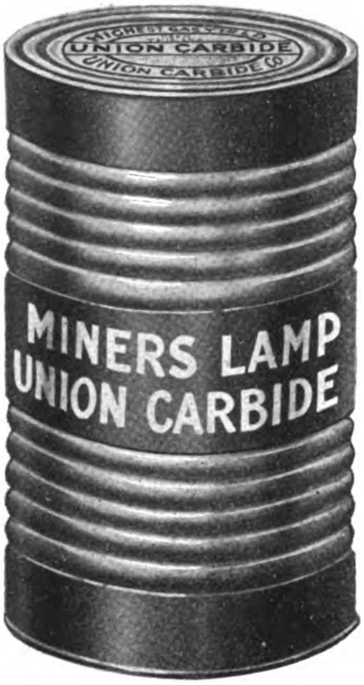
CHICAGO
Peoples Gas Bldg.

SAN FRANCISCO
Kohl Bldg.

Sole Distributors of

Highest Gas Yield **"Miners Lamp" Union Carbide** World's Best Quality

Manufactured by the Union Carbide Company, the Original Producers of Commercial Calcium Carbide and the Largest Manufacturers of This Product in the World.



"Miners Lamp" is a size of **"Union Carbide"** specially selected and adapted for use in miners' carbide lamps.

For the convenience of miners it is packed in 100-lb. and 25-lb. steel drums; also in 2-lb. and 10-lb. metal cans. All packages containing **"Miners Lamp" Union Carbide** are plainly marked and finished in **gray with blue bands.**

These blue and gray packages, easily identified, protect users against substitution and act as a guarantee that the contents are genuine **"Miners Lamp" Union Carbide,** acknowledged ‘‘The world's best quality.”

This high quality is the result of the use of purest raw materials, improved and exclusive manufacturing methods supervised by engineers connected with the Carbide Industry since its inception.

"Miners Lamp" Union Carbide is used today by 500,000 miners, who demand the best and will take no other.

Warehouses of the Union Carbide Sales Company are located at the following points:

ALABAMA
  Birmingham
  Mobile
  Montgomery

ARIZONA
  Phoenix

CALIFORNIA
  Eureka
  Fresno
  Los Angeles
  Sacramento
  San Diego
  San Francisco

COLORADO
  Denver
  Victor

CONNECTICUT
  Hartford

DISTRICT OF COLUMBIA
  Washington

FLORIDA
  Jacksonville
  Tampa

GEORGIA
  Atlanta
  Savannah

ILLINOIS
  Chicago
  Decatur
  East St. Louis
  Marion
  Monmouth
  Quincy
  Streator

INDIANA
  Evansville
  Indianapolis
  Terre Haute

IOWA
  Des Moines
  Dubuque
  Ottumwa
  Sioux City

KANSAS
  Pittsburg
  Salina
  Wichita

KENTUCKY
  Louisville

LOUISIANA
  New Orleans

MAINE
  Portland

MARYLAND
  Baltimore
  Cumberland
  Salisbury

MASSACHUSETTS
  Boston
  Cambridge
  Springfield

MICHIGAN
  Detroit
  Grand Rapids
  Hancock
  Iron Mountain
  Jackson
  Saginaw
  Sault Ste. Marie

MINNESOTA
  Minneapolis
  Virginia

MISSISSIPPI
  Vicksburg

MISSOURI
  Kansas City
  St. Joseph
  St. Louis

NEBRASKA
  Omaha

NEW HAMPSHIRE
  Concord

NEW JERSEY
  Camden
  Jersey City

NEW YORK
  Albany
  Binghamton
  Geneva
  Jamaica
  Kingston
  New York City
  Niagara Falls
  Poughkeepsie
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  Watertown
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NORTH CAROLINA
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  Erie
  Harrisburg
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  Pittsburgh
  Pottsville
  Scranton
  Williamsport

RHODE ISLAND
  Providence

SOUTH CAROLINA
  Charleston

TENNESSEE
  Chattanooga
  Knoxville
  Memphis
  Nashville

TEXAS
  Dallas
  El Paso
  Houston
  San Antonio
  Waco

UTAH
  Salt Lake City

VIRGINIA
  Lynchburg
  Norfolk
  Richmond

WEST VIRGINIA
  Bluefield
  Charleston
  Fairmont
  Huntington

WASHINGTON
  Seattle
  Spokane

WISCONSIN
  La Crosse
  Madison
  Milwaukee

Practically all jobbers and dealers in mine supplies handle **"Miners Lamp" Union Carbide.**

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

SAFETY FIRST AND FIRST AID SECTION

The following concerns have catalogue descriptions in this section:

Draeger Oxygen Apparatus Co.
Life Saving Devices Co.
Mine Safety Appliances Co.
Provident Life & Casualty Co.
Safety First Supply Co.
Stonehouse Steel Sign Co.
Williams Improved Stretcher Co.

For additional descriptions of Safety First and First Aid Equipment, not appearing in this section, refer to Index of Products in front of book.

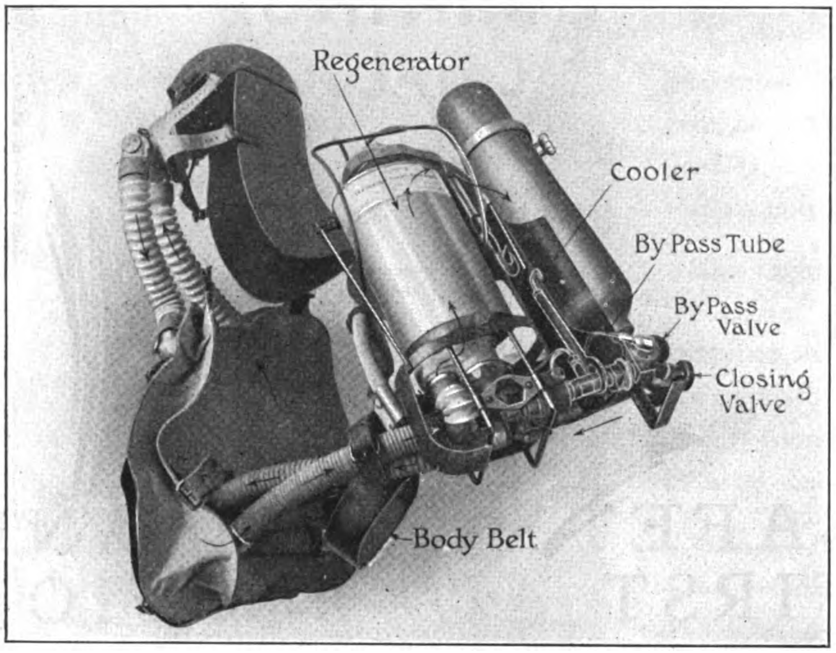
THE DRAEGER OXYGEN APPARATUS CO.

PENN AVE. AND HAY ST., WILKINSBURGH STA., PITTSBURGH, PA.

Mine Rescue Apparatus

and Pulmotors for Resuscitation

Agents for the Wolf Safety Lamp Company of America.



Standard 2-Hour Mining Apparatus with Mouth Breathing Device.

Standard 2-Hour Apparatus in Use.

The New 1917 Model Draeger Breathing Apparatus

In the construction of this New 1917 Model our engineers have been guided by the experience of users of Draeger Apparatus the country over and by suggestions from the U. S. Bureau of Mines.

The 1917 Model has a positive pressure circulation so that should the apparatus be slightly injured no poisonous gases from the outside can passibly enter—the leakage would be entirely outward.

A By-Pass Valve is provided by means of which the breathing bags may be instantly flooded with pure oxygen without waiting for its passage through the reducing valve.

Each apparatus is now supplied with two refilling regenerators—a distinctly new Draeger feature. This permits added training for your rescue crews at a greatly reduced expense, for you can now fill the regenerator right at your own plant.

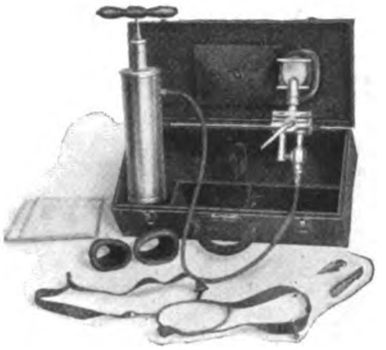
The frame has been remodeled, using magnalite castings wherever possible, which greatly reduces weight.

A new body strap or belt has been added which removes most of the weight from the wearer's shoulders and permits greater freedom of movement. The oxygen cylinder is also supported by a clamp at the top which removes its weight from the attached valve below.

All parts are easily adjustable, and subject to little or no wear.

For complete information on breathing apparatus and mine rescue equipment send for our new illustrated booklet containing in addition, letters of endorsement and lists of Draeger users in all fields.

Type B Pulmotor



Type "B" Pulmotor.

The type "B" is the only hand operated resuscitation apparatus operated on the recognized physiological principle of measured lung pressures. A patented Pressure Control Valve makes adaptation suitable for any patient and supplies his lungs with air exchanges identical in volume and pressure with those of natural breathing. Indicator Gauges signal the patient's first attempt at normal respiration and the patented control valve permits his spontaneous breathing while the mask is still on.

Price complete $125.00.

Machine Shop of Pittsburgh Plant.

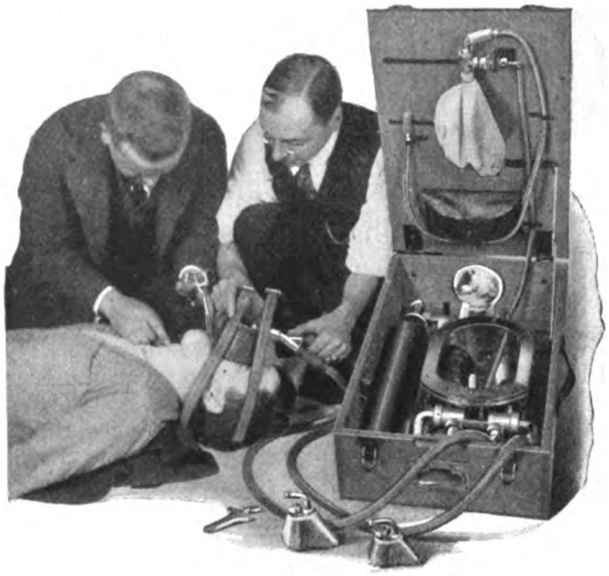
"Draeger" is the Only Mine Rescue Apparatus Made and Assembled Under One Management in America

Draeger apparatus is the only mine rescue and breathing apparatus of approved use and recognized standing made in the United States, and assembled under one management by the same men who make the parts.

This is a feature of vital importance in the consideration of apparatus of this kind. The very nature of its use demands that the apparatus be in perfect condition—the parts made, assembled and adjusted by the same men, men who know—and it calls for immediate replacement of parts broken or made unfit for service. The delays of trans-Atlantic shipment and the inconvenience of dealing with an agent who is often out of touch with his home office and foreign factory are only too apparent when property and lives are lost because parts and supplies cannot be obtained, and salvage must be abandoned.

Users of Draeger apparatus are always in direct touch with the Pittsburgh factory and shipment of parts and supplies can be put in transit immediately upon receipt of orders without the delay of sailing dates or the red tape of customs inspection.

Standard Pulmotor



Standard Pulmotor.

This apparatus is standard equipment for mining work; it has also been used successfully by thousands of hospitals and industrial concerns the world over. It is the original form upon which Pulmotor fame was built, but it is heavier than the type "B" and less easy to carry. It is automatic and operated by a compressed oxygen cylinder which insures its successful operation even in the hands of the most inexperienced.

Catalogues on request.

Assembly Room of Pittsburgh Plant.

MINE SAFETY APPLIANCES CO.

539-541 FOURTH AVENUE, PITTSBURGH, PA.

Safety Engineers

Everything for Mine and Industrial Safety Safety Appliances Exclusively

The Standard Equipment in Each and Every Line Carried

Products

Edison Electric Safety Mine Lamps, Approved Bulbs for Electric Lamps, Stonehouse Steel Signs, Fleuss Proto Mine Rescue Apparatus, Western Electric Mine Phones, Minimax Fire Extinguishers, Stokes Stretchers, M. S. A. Shot Firing Batteries, Tycos Anemometers and Barometers, Koehler Flame Safety Lamps, M. S. A. Lamp Testing Box, The Lungmotor, Safety Bulletin Boards, Sylat Post Pullers, Pyrene Fire Extinguishers, Williams' Stretchers, Davis Shot Firing Batteries, Davis Anemometers, Industrial Goggles, Burrel Gas Detectors.

Look on page 754 for Edison Mine Lamps.
Look on page 769 for Lungmotors.
Look on page 774 for Stonehouse Steel Signs.
Look on page 773 for Williams' Stretchers.

M. S. A. Pocket First Aid Packet

The M. S. A. Ever Ready First Aid Pocket Packets are complete equipments for small injuries of any description. They are much more comprehensive than any other pocket packet now on the market; eight items comprise these most compact pocket kits. One large coal company has more than two thousand of these packets in daily use.

M. S. A. Ever Ready First Aid Pocket Packet.

M. S. A. Stretcher Outfits

Our Special M. S. A. Stretcher outfit is tightly enclosed in a strong made galvanized cannister 9 inches in diameter by 8 feet long, thus being kept clean and dry in dusty or in damp places; so that, when the call comes for the equipment it is ready for immediate service. The cannister is provided with two stout handles so that it can be readily transported to the scene of the accident.

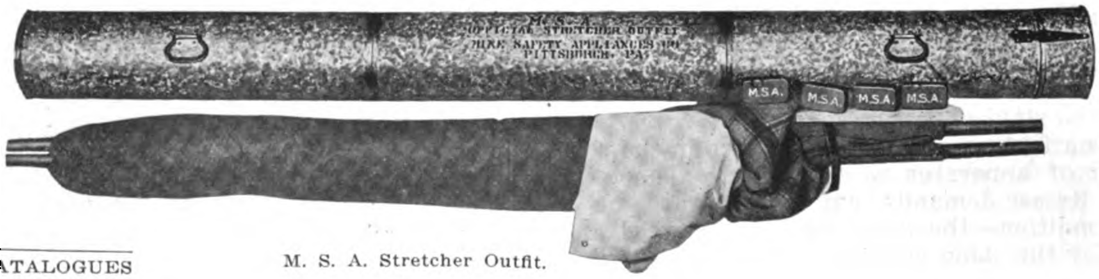
The complete outfit consists of the following: Galvanized Cannister, U. S. Army or Williams' Stretcher, Double Wool Blanket, Heavy Rubber Blanket, Splints, Triangular Bandages and four M. S. A. Pocket Kits.

M. S. A. First Aid Cabinets

The M. S. A. No. 5 First Aid Cabinet is a complete emergency equipment in more compact form and in more convenient size than any other cabinet now on the market. Although the M. S. A.cabinet contains a complete First Aid equipment of 60 items, it costs less than any other cabinet now on the market. We guarantee the contents to fulfill the requirements of the Insurance Inspection, and the State Mining and Factory Inspection Departments.

Contents

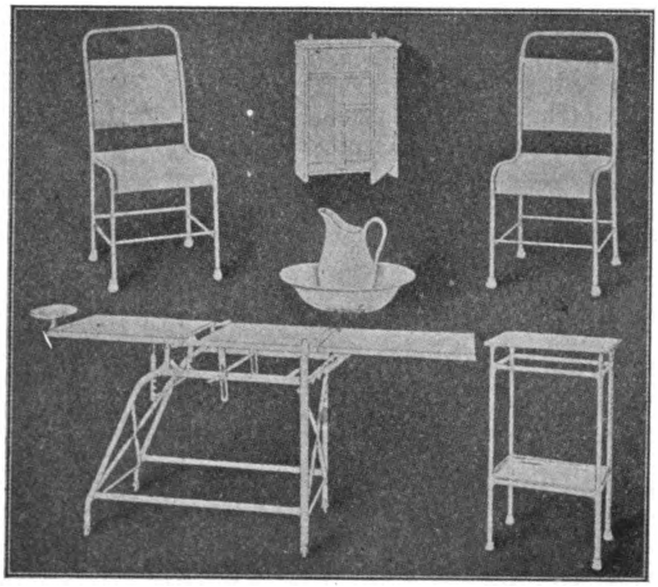
1 Steel Box; 2 Keys for same; 1 Tourniquet; 3 Plain Gauze Paskets; 1 Doz. Swabs; 1 No. 4 Packet; 1 Doz. Safety Pins; 2 Burn Pressing Packets; 4 Triangular Bandages; 2 Special Z. O. Plasters; 1 Wire Splint; 1 Pair Scissors; 1 2-oz. Bottle Iodine; 1 Bottle Comphenol; 1 Jar Boric Acid Ointment 1 Bottle Aromatic Spirits; 1 yd. Plain Gauze; 3 Packets Absorbent Cotton; 22 Assorted Compress Bandages; 14 Assorted Roller Bandages.



M. S. A. Stretcher Outfit.

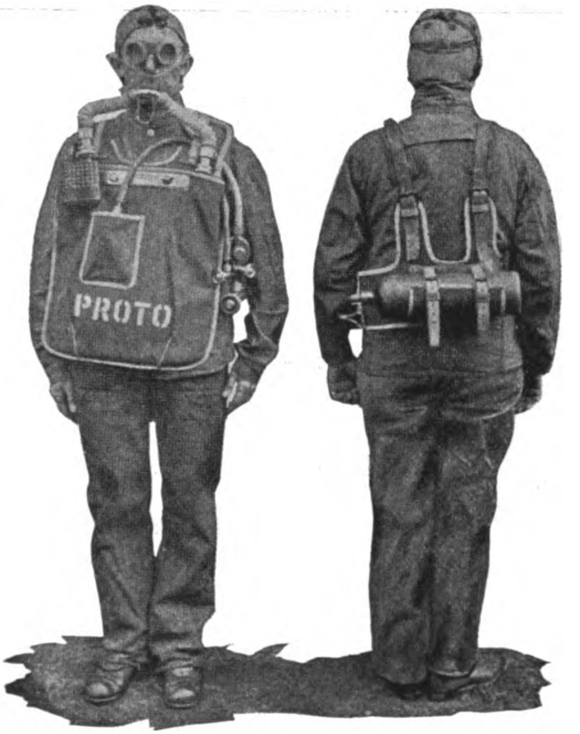
M. S. A. Emergency Hospital Equipment

The equipment shown in the illustration is the M. S. A. One Room Hospital Equipment. This is an Officially Approved Emergency Room Equipment, for mines and industrial plants, and consists of the following: Operating Table and Cushions, Wall Cabinet, Instrument Table, two Chairs, one Basin, and one Pitcher. An instrument sterilizer and gas stand to complete the equipment at an extra cost.



One Room Hospital Equipment.

We also build a three room hospital unit, complete in all details. In addition, we are prepared to furnish the following materials singly or in any combination. Chair with head rest and removable arm with basin attachment and basin for hand dressing; foot dressing stand and basin attachment; plain chair; couch and cushion, blanket and pillow; instrument tray; pitcher and basin; instrument table; cabinet filled with supplies; sterilizer and burner with deep base for sterile water; stretcher; wool blanket; irrigator; waste pail; irrigator tubing and tips; towels with "Emergency Room" woven into them; operating table and cushions.



Front View. Back View.

Fleuss Proto Breathing Apparatus

The Two-Hour Fleuss Proto Apparatus, which is now the standard Oxygen Apparatus for mine rescue and recovery work in this country, fulfils all the requirements of the U. S. Bureau of Mines.

The Fleuss Proto differs from all other breathing apparatus using compressed oxygen, dispensing with the use of injectors and helmets. The recommendations of the U. S. Bureau of Mines, regarding breathing apparatus, are that the circulation shall be under positive pressure throughout, and the apparatus shall be equipped with a by-pass valve, and be of the mouth breathing type exclusively. The Fleuss Proto is the only apparatus which complies with these requirements, and did so years in advance of the recommendations, by dispensing with the helmet, which requires the use of an injector, in order to cause a continuous flow of air through the helmet to clear out the dead air spaces.

Advantages of the Fleuss Proto

All of the circulating system is confined to the front of the wearer and there is nothing on the back except the oxygen bottle, which cannot be damaged. A man wearing this apparatus can crawl through an aperture of 15 inches. Other advantages are:

1. Entire apparatus under positive pressure.
2. All operating valves in plain view of the wearer.
3. Minimum number of parts and connections.
4. Weight complete 34 pounds.
5. By-pass valve to care for emergencies.
6. Loose caustic soda in regenerator.
7. Sanitary features of Breathing Bag.

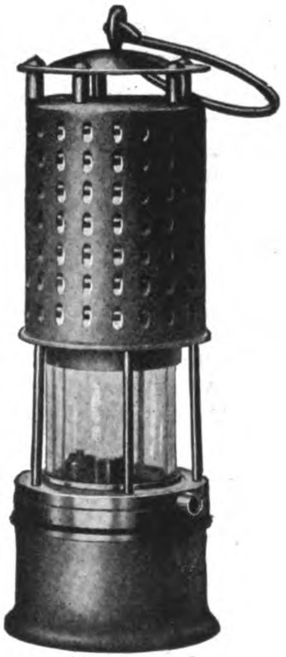
Some companies that installed Fleuss Apparatus during 1916-1917:

H. C. Frick Coke Co.
Vesta Coal Co.
Solvay Collieries Co.
Lehigh & Wilkes-Barre Coal Co.
Keystone Coal & Coke Co.
Pittsburgh Coal Co.
Consolidation Coal Co.
Lehigh Valley Coal Co.
Calumet & Hecla Mining Co.
Jamison Coal & Coke Co.

The U. S. Bureau of Mines are using 150 Fleuss Apparatus, 65 of which have been purchased during 1917, replacing other types.

Koehler Safety Mine Lamps

The Koehler lamp is a double gauze bonneted lamp of the naphtha burning type, taking air from below the flame. The ventilation is so controlled that the lamp does not heat up, therefore it requires less adjustment of the flame. It also gives a higher and more uniform illumination.



Model No. 2.

As a result of the greater flame intensity and steadyness it is certain and more sensitive in its indications of gas, so that a smaller percentage of gas can be detected with this lamp than with any other lamy in general use. Under test it has shown results as follows: Indications at ½% of gas; 3/16″ cap at ¾% of gas; ⅜″ cap at 1% of gas; a ⅖″ cap at 1½% of gas, and a 1⅛″ cap at 2%.

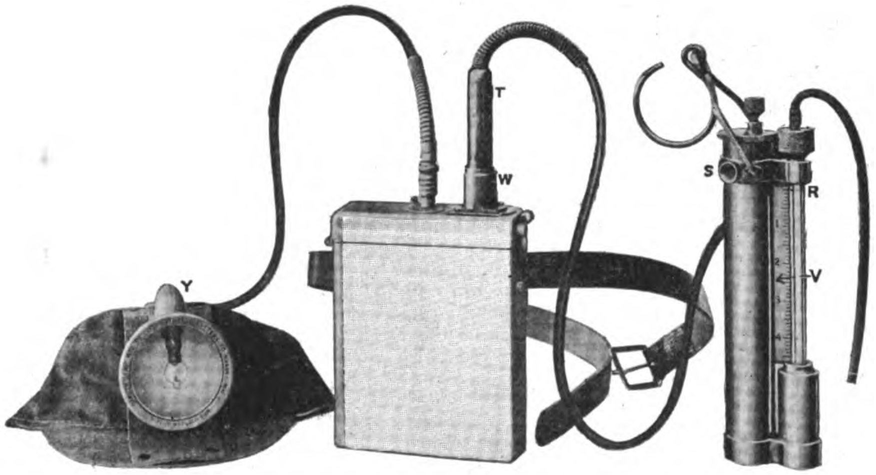
As well as making it a better testing lamp, its high illuminating power makes it the best type of lamp for traveling and working purposes.

The Burrell Gas Detector—Its Purpose

The Burrell gas detector is not a working lamp but an instrument for the accurate determination of very small percentages of methane or "fire-damp". While the most approved type of flame safety lamp will not detect less than one percent of methane, even in the hands of the most expert observer, the Burrell will show as low as 1/10 of one percent in the hands of the skilled observer.

Theory of Operation

In constructing the detector advantage was taken of the fact that methane when it burns to complete combustion, burns to water and carbon dioxide. Due to chemical change and the condensation of the water formed in burning, there is a decrease in volume which can be proven to equal twice the volume of the methane in the air entering. In the operation, a known quantity of air is drawn into the detector, as explained later, and the methane burned out by means of an electric glower. The consequent reduction in volume takes place and the percentage of methane is read off the scale.



Burrell Detector.

Edison Special Shot Firing Battery.

M. S. A. Special Oxygen Cylinder. Capacity 100 cu. ft. Length 36 inches. Weight 80 lbs. charged.

Other combustible materials than methane will, of course, introduce an error, but the Bureau of Mines has found as the result of thousands of analyses of gases found in coal mines that methane is the combustible gas found in normal mine air, i. e., mine air not contaminated by gases from explosives, fires, etc.

Explosion Proof

The instrument is explosion proof. Flame cannot get out of the apparatus. If an explosive mixture is drawn into the apparatus, it explodes, but the ony result is that pressure is exterted on the water level and a few drops are forced out the tube. If this happens water must be replaced in the apparatus.

Electric Current from Edison Lamp

The gas detector is shown above connected to the Edison Mine Lamp Battery. The cord provides the connection. At one end of this cord is a plug T that easily slides into a posket W. The latter is permanently fastened to the storage battery. The other end of the cord is permanently fastened to the gas detector and as securely and as safely fastened as the lamp cord on any approved safety lamp.

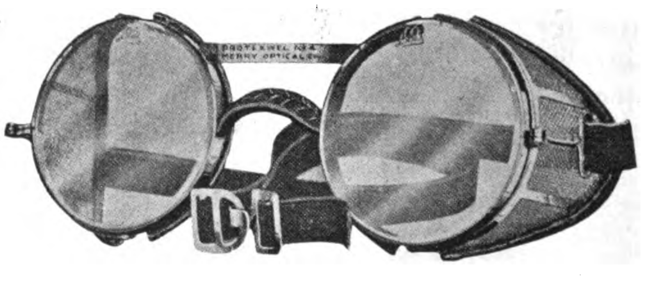
The gas detector and the cord form a permanent unit. To use the instrument, i. e., to light the platinum glower in the detector, the plug is inserted and given a 90 degree turn. This throws part of the electric current into the detector. The Edison Cap lamp itself remains lighted during the conductance of the test.

The gas detector is connected to the Edison electric safety mine lamp, for which lamp the Mine Safety Appliance Company is the sole distributor in the United States. As there are today over 90,000 Edison Mine lamps in use in U. S. A., the Burrell Detector has before it a wide field of usefulness in the mining industry.

Oxygen and Oxygen Cylinders

Ready for Emergency Calls.

We carry in our Pittsburgh stock rooms a large consignment of special M. S. A. Oxygen Cylinders filled and ready for emergency call. Send for us in time of accident or disaster. We have all the necessary equipment ready for use. Our ten M. S. A. Safety Engineers are at your serivce for the asking. Call on us at any time to assist you in your safety work.



"Protexwel" Eye Protectors

Will save your workmen's eyes.

We have eye protectors for every purpose. Send for catalogue, prices and samples.

LIFE SAVING DEVICES CO.

565 W. MONROE STREET, CHICAGO

The Lungmotor

A Life-Saving Device

"Respiration with apparatus is superior to the manual method," says a recent issue of the Journal of the American Medical Association. Then follows the reason for the statement "because the apparatus is capable of giving a normal volume of pulmonary ventilation while the manual method is not.—It should be of the simple type."

The Simplicity of the Lungmotor

The Lungmotor conforms in this specification of simplicity. The Lungmotor is in use by the U.S. Government, Foreign Government and over 4,000 mines, industrial concerns, hospitals, municipalities all over the world and in the majority of cases operated under the supervision and direction of laymen and saving lives daily. That the Lungmotor is simple and efficient is proved by these many lives saved through its use in these communities.

The One Properly Constructed Device.

The Lungmotor is the one correctly built mechanical respirator that puts the breath of life into human beings who have been apparently "Killed" by electric shock, asphyxiation, drowning, gas and smoke, poisoning, strangulation, mine accidents and collapse during anaesthesia etc.

The Lungmotor goes back of all known test for "Life" and assuming that there is life, starts normal respiration, and maintains this regular breathing until nature recommends the functions so abruptly interrupted.

Bought By the United States Government

The United States Government after the most exhaustive tests, have ordered Lungmotors in face of all competition, for use on Battleships, Navy Yards, War Department, Reclamation Service and wherever else the opportunity exists for saving life by prolonged mechanical breathing under normal conditions.

Not once where actual life saving ability was the question has the Lungmotor failed to win highest honors; and not once wherein competition with any other so called mechanical respirator has the Jury of Award failed to recommend the true mechanical method employed.

From the standpoint of dollars and cents the life of an employee under the Compensation Law may cost you as high as $7,500 or as little as $2,500.

In either case an extremely high penalty to pay in order that you may temporarily save the cost of the Lungmotor, only $135.00.

If you keep a revolver in the house to guard your family against the burglar that may one night threaten their lives—

If you carry insurance against the fire that may one day destroy your property—

You will surely want to know all about the Lungmotor which may some day prevent one or a dozen deaths in your organization.

A Few Strong Points of the Lungmotor

Dependable—Always ready for use—Nothing to get out of order.

All metal non-corrosive. No washers, springs or gaskets.

Light weight—Compact.

Takes care of all water, slime and mucus, without removing face mask.

Gives air or oxygen in any percentage or pure air or pure oxygen.

Instantly adjustable for newborn to largest adult.

Gives tidal volume of air. The amount you would naturally breath.

Gives air at a safe pressure—always below a definite maximum.

Has absolutely no direct suction on the lung tissue.

Always keep the lung full of air.

You can give inspiration without expiration.

You cannot increase or decrease respiration at will.

Anyone—even a small boy—can operate it.

It can be used anywhere under any circumstances, on stretchers, in rocking boats, etc.

Simple, safe and efficient.

In every instance where shown the Lungmotor has received the highest awards:—

International Exposition of Safety & Sanitation, under auspices American Museum of Safety.

Grand Prize and Gold Medal, New York City, Dec., 1914. No exposition in 1915.

Grand Prize and Gold Medal New York City, May, 1916.

Examination and Certificate of Approval issued by Industrial Board of the Pennsylvania Dept. of Labor and Industry, 1916.

Panama Pacific International Exposition, 1915.

Gold Medal of Honor, (highest award) by Mining Jury.

Gold Medal (highest award) by Liberal Arts Jury.

California Pacific Exposition, 1915-1916, Gold Medal.

We also present THE "LIFE SAVING" BREATHING DEVICE which permits continuous work in atmospheres where gas or fumes is a menace. AN IMPROVED STRETCHER—"BIGGEST IMPROVEMENT IN STRETCHERS SINCE CIVIL WAR." Does away with lifting and rolling of injured, in moving to bed or operating table.

SAFETY FIRST SUPPLY COMPANY

Offices and Salesrooms: Hartje Office Bldg.
Warehouse: No. 18 Wood Street
Pittsburgh, Pennsylvania

Safety Appliances and Equipment

Ask for the Bulletins Which Interest You. Complete Catalog on Request

Diamond Porcelain Signs

Bulletin No.	
1	Safety and Warning Signs.
2	Electrical, Railway and Machinery Signs.
3	Mine Signs.
4	No Smoking; No Admittance and Warning Signs.
5	Safety First and Notice Signs.
6	Machinery Signs.
7	Safety Signs.

Charts

Bulletin No.	
101	First Aid and Electrical Resuscitation. Printed on heavy linen paper. Two colors. Illustrated. Large print.

First Aid

Bulletin No.	
102	Diamond First Aid Cases, Pocket Packets.
103	Williams' Stretchers, Emergency Outfits.
106	Stokes' Stretchers, Splints.
107	McNeil First Aid Cases.
108	Bandages, Adhesive, First Aid Dressings.
109	Iodine, Ammonia, Carron Oil, etc.
110	Pocket Packets, Stretchers.
111	First Aid Outfits.

Hospital Equipment

Bulletin No.	
105	Diamond Equipment No. 1 and Diamond Equipment No. 2.
105A	Diamond Equipment No. 3 and Diamond Equipment No. 4. These Equipments consist of the essential Furniture, Instruments and Dressings necessary for Industrial Hospitals. See page 771 in this book.

Fire Extinguishers and Non-Explosive Cans

Bulletin No.	
202	

Playground Apparatus

Bulletin No.	
225	"The More Playgrounds—The Fewer Plague Grounds." See page 772 in this book.

Bulletin Boards

Bulletin No.	
301	Diamond No. 28—Size 28 x 30". Diamond No. 56—Size 56 x 30". Constructed entirely of metal, illuminated by electric lights. Weather-proof. Everlasting, Attractive and Effective.

Suggestion Boxes and Waste Paper Balers

Bulletin No.	
300	Recommended by all insurance companies.

Safety Ladder Shoes

Bulletin No.	
302	Guaranteed to prevent accidents.

Switchboard Mats

Bulletin No.	
302	Diamond Rubber Mats for Power Plants.

Guards

Bulletin No.	
303	Manufactured and Erected. Diamond Expanded Metal for manufacturing Safety Guards for Machinery.

Draeger Apparatus

Bulletin No.	
304	Mine Rescue Machines. Pulmotors—Breathing Apparatus.

Safety Leaflets

Bulletin No.	
305	For Coal Miners. Twenty-four Pages. One Hundred and Twelve Illustrations, Printed in Eight Languages.

Telephones

Bulletin No.	
306	Mine, Surface, Wall and Desk.

Respirators and Sand-Blast Helmets

Bulletin No.	
307	

Mine Tail Lanterns and Trip Alarms

Bulletin No.	
308	

Sylat Post Pullers

Bulletin No.	
308	

Powder Flasks

Bulletin No.	
309	Insulated against explosion from electricity. Safety Fiber Pails—Standard Fiber Pails.

Goggles

Bulletin No.	
307	Gas Tight Rubber Goggles.
313	Diamond Safety Goggles—Goggle Cases.
314	Hardy Welding Goggles—Harco Safety Goggles.
315	Safety Goggles—Dust Goggles.

Drinking Fountains

Bulletin No.	
310	Save water and save time by using the clean, sanitary Diamond Drinking Fountains.

Valves

Bulletin No.	
312	Fire Protection and Safety. For Gas, Air, Oil, Water and Steam.

Disinfectants

Bulletin No.	
320	Dry Powder. Liquid.

Leggins, Gloves, Mittens

Bulletin No.	
325	Made of Asbestos Fiber.

Emery Wheel Guards and Stands

Bulletin No.	
401	

Saw Guards, Jointer Guards

Bulletin No.	
402	

Steel Lockers
Cartoons and Charts for Bulletin Boards
Shaft Oiling Devices
Drinking Cups and Holders
Safety Buttons and Fobs
Rubber Gloves
Safety Shoes for Iron-Workers, Chemical Workers, Etc.

Above appliances are guaranteed to fulfill the requirements of the Compensation Laws and of the Insurance Companies. Each appliance is of the best quality obtainable and is sold under our positive guarantee of highest efficiency.

Additional Bulletins issued at frequent intervals. Get on our mailing list.

SAFETY FIRST SUPPLY COMPANY

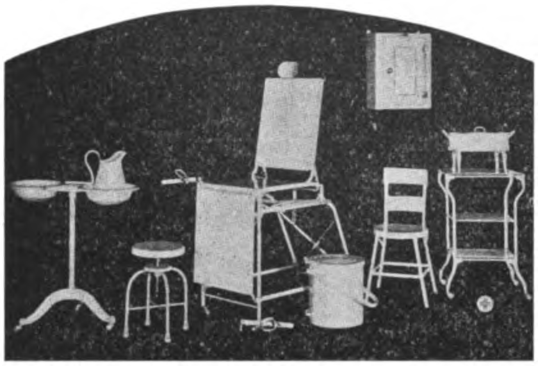
PITTSBURGH, PA.

Diamond Emergency Hospital Equipments

Furniture:

1 U. S. Operating Table.
1 Stand with Three Glass Shelves.
1 2-Basin Stand with Basins.
1 Steel Wall Cabinet with Mirror.
1 Steel Chair with Back.
1 Revolving Stool.
1 8-gallon Waste Bucket.
1 Sterilizer with Stand.
1 2-quart Pitcher.

Every item listed above is of heavy steel construction and heavily coated with white porcelain enamel.



Accessories:

1 Straight Scissors.
1 Bandage Scissors 5½ inches.
1 Scalpel.
1 Bistourie.
1 Gross Safety Pins, Medium.
10 1-yd. Pkgs. Plain Sterile Gauze.
2 1-yd. Jars Iodoform Gauze, 5%.
1 Doz. 1-inch Gauze Bandages.
1 Doz. 2-inch Gauze Bandages.
2 Lbs. Absorbent Cotton, 4 oz. pkgs.
2 Rolls 1-inch Z.O. Adhesive Plaster.
1 Jar Plain Sterile Catgut, 3 sizes.
1 Jar Plain Sterile Silk, 3 sizes.
1 Doz. Surgeon's Needles, assorted.
2 Haemostats.
1 Box Wood Applicators, 6 inches.
1 Pair Probes, 5 inches.
1 Box Wood Tongue Depressors.
1 Eye Spud and Needle.
100 Antiseptic Tablets.
6 Large Tubes Carron Oil, Solidified.
4 ozs. Aromatic Spirits of Ammonia.
2 ozs. Tr. Iron Chloride.
¼ Lb. Sodium Bi-Carbonate.
1 10-oz. Bottle Synol Antiseptic Soap.
1 Doz. Diamond Iodine Applicators.

The Accessories in the above list are the best materials obtainable and are guaranteed to be the necessities for First Aid.

Diamond Emergency Hospital Equipment No. 2

Price, complete with furniture and accessories........ **$110.00**

Diamond Emergency Hospital Equipment No. 1

Furniture:

1 U. S. Operating Table.
1 Stand with Two Porcelain Shelves.
1 Steel Wall Cabinet with Mirror.
1 Single Basin Stand with Basin.
1 2-quart Pitcher.
1 Steel Chair with Back.
1 Steel Stool.
1 Sterilizer with Stand.

Every item listed above is of heavy steel construction and heavily coated with white porcelain enamel.

Accessories:

1 Scalpel.
1 Doz. Needles, assorted.
1 Pair Straight Scissors.
2 Haemostats.
1 Gross Safety Pins, medium.
1 Doz. Diamond Ammonia Ampules.
½ Doz. Diamond Iodine Applicators.
1 Large Tube Carron Oil, Solidified.
5 1-yd. Pkgs. Plain Sterile Gauze.
2 1-yd. Jars Iodoform Gauze, 5%.
1 Doz. 1-inch Gauze Bandages.
1 Doz. 2-inch Gauze Bandages.
1 Lb. Absorbent Cotton, 4 oz. packages.
1 Roll Z. O. Adhesive Plaster, 1 inch.
1 Jar Plain Sterile Catgut, 3 sizes.
1 Jar Plain Sterile Silk, 3 sizes.

The Accessories in the above list are of the best materials obtainable and are guaranteed to be the necessities for First Aid.

Price, complete with furniture and Accessories........ **$80.00**

Diamond Emergency Hospital Equipment No. 3

1 Franklin Operationg Table with Cushions.
1 Instrument Table, 18" x 30".
1 Storage Table.
1 8-gallon Waste Bucket.
1 Irrigator with Immersion Stand.
1 Treatment Table and Cabinet Combined.
1 Revolving Stool.
1 Steel Chair.
1 Electric Sterilizer 16" x 6" x 3½".

Price, complete without sterilizer........ **$175.00**
Price, complete with sterilizer........ **$203.00**

Diamond Emergency Hospital Equipment No. 4

1 Moscow Operating Table with Cushions.
1 Glass Sides and Shelf Instrument Cabinet.
1 Mayo Instrument Stand.
1 30-in. Adj. Revolving Stool.
1 illuminator, complete with Cord, N. P. Shade and Bulb.
1 Tubular Chair.
1 Instrument Table with Rail and Bottles.
1 8-gallon Waste Bucket.
1 Leg Dressing Stand with Basin Attachment and Basin.
1 Three Basin Immersion Stand.
1 Adj. Irrigator, with Basin, 1 Gal. Percolator, Tubing and Cutoff.
1 Adj. Treatment Chair with Adj. Arm Rests.
1 Instrument Supply Stand.
1 Electric Sterilizer 16" x 6" x 3½".

Price, complete without sterilizer........ **$240.00**
Price, complete with sterilizer........ **$268.00**

These complete outfits have met with the universal endorsement and approval of mine and plant physicians. The outfits shown have been installed in some of the leading industries of this country. They are especially adapted for the various size plants for which they are sold. Each article of furniture is subjected to a rigid test before leaving the factory and is guaranteed to be perfect in every respect and to fulfill every purpose for which it is intended.

We guarantee these outfits to meet all the requirements of the Insurance Companies and the Compensation Law.

If the above Equipments do not meet your requirements we would be pleased to submit to you prices and literature on other styles.

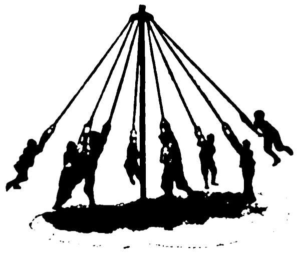
SAFETY FIRST SUPPLY COMPANY

PITTSBURGH. PA.

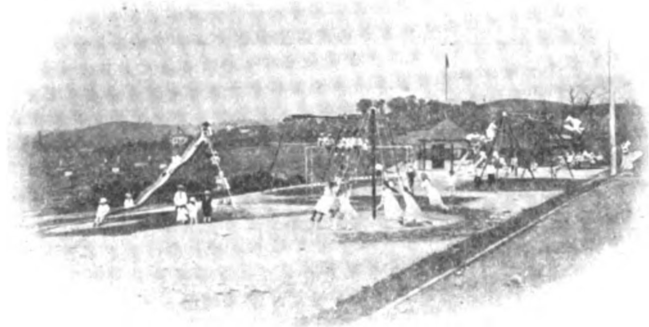
Diamond All-Steel Playground Apparatus

HAS NO COMPLEX PARTS NEEDING CONSTANT SUPERVISION.
IS DURABLE AND WEARS FOR YEARS.
REQUIRES NO SUPERFLUOUS PIPING.
ALWAYS INSURES SAFETY TO USERS.
IS ABSOLUTELY GUARANTEED TO BE UNEQUALLED FOR

STRENGTH—DURABILITY—SIMPLICITY—SAFETY



Giant Stride.



Diamond Playground Apparatus Installed at Keystone Shaft Mine, Keystone C. & C. Co., Madison, Pa.

Swings.

See-Saw.

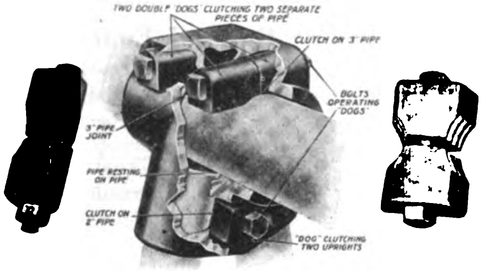
Slides.

Merry-Go-Round.

CONSTRUCTION

All fittings in Diamond All-Steel Playground Apparatus are Malleable and Threadless. Fittings are equipped with double compression dogs, eliminating all threads and set screws and any drilling of either fittings or pipe.

See sectional cut.



Compression Dogs and Bolt.

These fittings when attached to the pipe are positive in application and lock the whole framework to perfect rigidity.

All Playground Apparatus is subjected to much vibration and strain, but by the use of our compression "dog" fittings it is an impossibility for any pipe connection to become loose or insecure.

All Diamond fittings are made to fit standard size pipe and by their use the cost of erection and assembling is reduced to a minimum.

All bearing parts in this Apparatus are equipped with either steel ball or steel roller bearings.

Special Catalogue, Estimates and plans furnished on request.

An installation of Diamond All-Steel Playground Apparatus will justify its cost many times in its effect upon your organization.

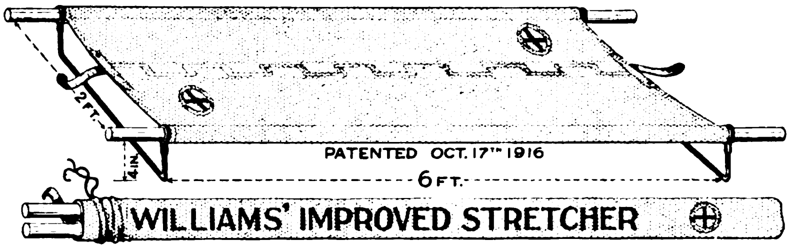
Williams' Improved Stretcher Company

No. 1202-1204 Water Street, Wheeling, W. Va.

"IT CUTS THE PAIN IN HALF"

(Williams' Improved Humane Stretcher)

Cut shows Stretcher ready for patient.



Nothing like it except another of same make.

Our Stretcher has more exclusive points than any other made.

First: It does away with all unnecessary lifting.

Second: Economical. Extra cots can be bought, you don't have to buy a complete Stretcher.

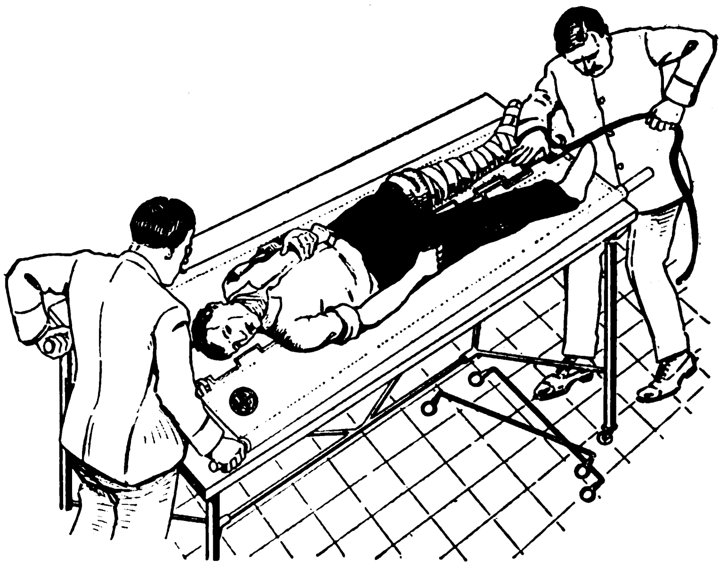
Third: Sanitary. The Stretcher is sold in a clean, dust and mildew proof khaki bag which keeps it clean, always ready for use.

Used by the leading coal operators. We are adding new names daily.

We aim to keep a stock of Stretchers on hand continually for rush orders. Most up-to-date mine and mill supply houses stock them also.

Send for descriptive booklet—before your next accident.

THE STRETCHER THAT'S DIFFERENT.



Cut shows stretcher being removed from the patient.

THE STONEHOUSE STEEL SIGN CO.

CLAYTON BLOCK, DENVER, COLO.

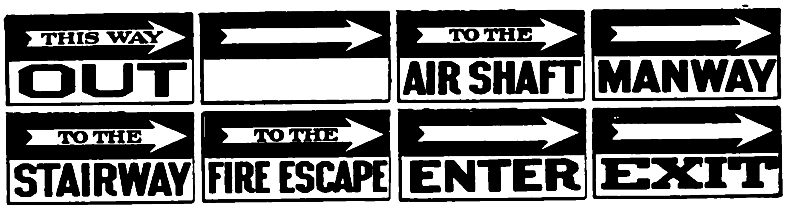
Mine Safety Appliances Co., 539-41 Fourth Avenue, Pittsburgh, Pa.
Agents for Pennsylvania and Kentucky.

Striking---Attention Arresting, Accident Prevention, Signs, Safety Bulletin Boards.
Danger and Safety Tags

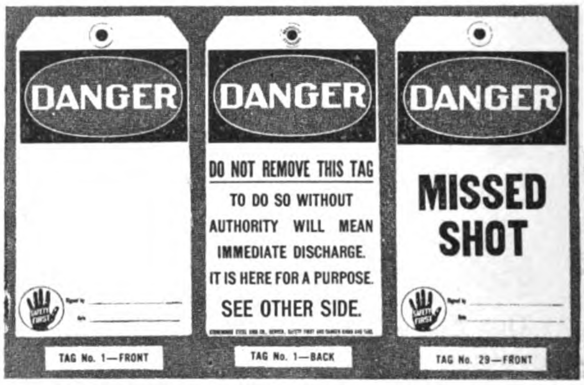
Which of These Signs Below is the Practical DANGER Sign

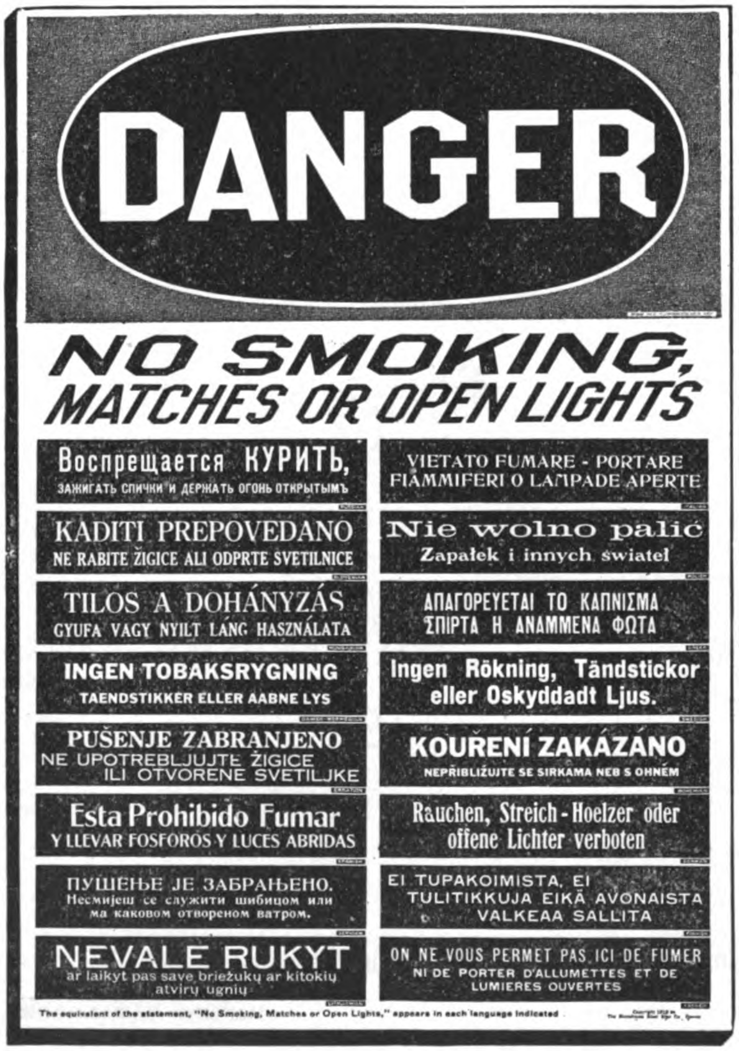
This style of sign mentions the specific DANGER, giving you a chance to protect yourself, employees and the public.

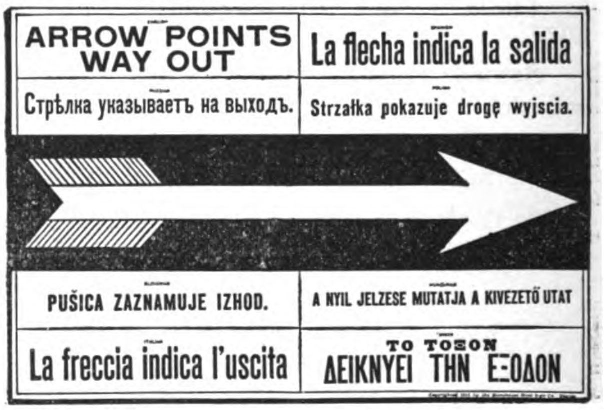
This style sign does not advise where the DANGER exists, whether overhead, under foot, to the right or left, in front, or behind.



What has been said here of Danger Signs also applies to Arrow Signs. The Arrow indicates direction, but unless the thing is indicated it loses much of its force.




DANGER
NO SMOKING,
MATCHES OR OPEN LIGHTS
Воспрещается КУРИТЬ,
ЗАЖИГАТЬ СПИЧКИ И ДЕРЖАТЬ ОГОНЬ ОТКРЫТЫМЪ
VIETATO FUMARE - PORTARE
FIAMMIFERI O LAMPADE APERTE
KADITI PREPOVEDANO
NE RABITE ŽIGICE ALI ODPRTE SVETILNICE
Nie wolno palić
Zapałek i innych świateł
TILOS A DOHÁNYZÁS
GYUFA VAGY NYILT LÁNG HASZNÁLATA
ΑΠΑΓΟΡΕΥΕΤΑΙ ΤΟ ΚΑΠΝΙΣΜΑ
ΣΠΙΡΤΑ Η ΑΝΑΜΜΕΝΑ ΦΩΤΑ
INGEN TOBAKSRYGNING
TAENDSTIKKER ELLER AABNE LYS
Ingen Rökning, Tändstickor
eller Oskyddadt Ljus.
PUŠENJE ZABRANJENO
NE UPOTREBLJUJTE ŽIGICE
ILI OTVORENE SVETILJKE
KOUŘENÍ ZAKÁZÁNO
NEPŘIBLIŽUJTE SE SIRKAMA NEB S OHNĚM
Esta Prohibido Fumar
Y LLEVAR FOSFOROS Y LUCES ABRIDAS
Rauchen, Streich-Hoelzer oder
offene Lichter verboten
ПУШЕЊЕ ЈЕ ЗАБРАЊЕНО.
Несмијеш се служити шибицом или
ма каковом отвореном ватром.
EI TUPAKOIMISTA, EI
TULITIKKUJA EIKÄ AVONAISTA
VALKEAA SALLITA
NEVALE RUKYT
ar laikyt pas save briežukų ar kitokių
atvirų ugnių
ON NE VOUS PERMET PAS ICI DE FUMER
NI DE PORTER D'ALLUMETTES ET DE
LUMIERES OUVERTES
The equivalent of the statement, "No Smoking, Matches or Open Lights," appears in each language indicated


ARROW POINTS
WAY OUT
La flecha indica la salida
Стрѣлка указываетъ на выходъ.
Strzałka pokazuje drogę wyjscia.
PUŠICA ZAZNAMUJE IZHOD.
A NYIL JELZESE MUTATJA A KIVEZETŐ UTAT
La freccia indica l'uscita
ΔΕΙΚΝΥΕΙ ΤΗΝ ΕΞΟΔΟΝ

Accident Prevention Signs

Not a jumble of words on a steel plate, but real Safety signs with a punch.

Signs that prevent accidents because their quality is so striking, so attention arresting, that they are rightfully termed Accident Preventors.

Three hundred or more different kinds of these signs are in stock today ready for immediate shipment and they are ready every day.

Our signs are the best money can buy in both material and workmanship (of course), but the main thing is that they are STANDARD.

No other sign company in the United States emphasizes this fact, but from a money-saving standpoint it is very essential. Ask any Insurance Man or Mine Inspector.

The real story of signs can't be told in a one-page advertisement.

Send for our free illustrated folder.

PROVIDENT LIFE & CASUALTY CO.

CHARLESTON, W. VA.

Workmen's Compensation Troubles Minimized

Mine operators all over the country are realizing that a miner who takes pride in his work, his home and his family, is indeed a valuable asset.

Furthermore, a great many operators are trying to make the living conditions about their mines more attractive, so that the miners will feel that they are "human beings" and have an equal chance to live happily and progress, as any of their associates of co-workers. It is a laudable stand for any operator to take, to try to improve the sociological conditions of his mines; indeed, it is regarded as an investment by the operator with foresight.

An insurance policy for the mine employee, gives him a sense of security and reflects in the efficiency of his work.

Every operator should encourage his employees to take out an insurance policy such as we issue, as it gives the miner or other employee a sense of his responsibility and duty to his family and makes him a more permanant citizen or inhabitant of the community.

To Corporations who accept the plan of Industrial, Accident and Health Insurance, offered by this company, much annoyance, and delay are saved.

Our company is managed by experienced coal men who know the problems of the operators and miners.

Here is the Plan we have Adopted:

Our agents solicit the applicant for insurance.

The applicant gives an order to his employer for the collection of premiums.

The Policy is issued from the Home Office and sent to the bookkeeper or collector for delivery to applicant.

A list of policy holders is sent each month to bookkeeper or collector where assured is employed, for collection of monthly premiums.

Claims are made out by the bookkeeper or collector, and doctor, on blanks furnished, and are paid through the bookkeeper's office or the Company's collector.

The bookkeeper or collector is not liable for any premiums not collected.

This plan saves any annoying correspondence or looking up agents to secure a claim.

We advance money on claims of long duration where the proper notice has been given to the Company of the commencement of disability.

Attractive Features of Our Leader Policy

It is a plain and simple contract. Its provisions can be understood by anyone.

It does not contain catchy or misleading clauses, and is free from technicalities.

It does not require any correspondence or looking up agents to secure payment of claims.

It gives full protection against accident, sickness or death, at all times.

It pays its claims promptly.

KEYSTONE
THE.
MINING
CATALOG
CONSOLIDATED PUBLISHING
COMPANY INC.

MINE SUPPLY SECTION

The following concerns have catalogue descriptions in this section:

Burson Suply Co.
Childs, H. L. & Co., Inc.
Colonial Supply Co.
Duff Mfg. Co.
Frick & Lindsay Co.
Harris Pump & Supply Co.
James, Edward F. Sales Co.
Joyce-Cridland Co., The.
Railway & Mine Supply Co.
Scallon Supply Co.
Smith, L. C. & Bro. Typewriter Co.
Standard Sanitary Mfg. Co., The.
Turner, C. A. Inc.
Templeton, Kenly & Co., Ltd.
Tranter Mfg. Co.
U. S. Hame Co.

For additional descriptions of Mine Supplies, not appearing in this section, refer to Index of Products in front of book.

THE DUFF MANUFACTURING CO

Main Office and Works
PITTSBURGH, PA

New York—50 Church Street.
Atlanta—Candler Building.
St. Paul—Pioneer Building.
Chicago—Peoples Gas Building.
San Francisco—Monadnock Building.

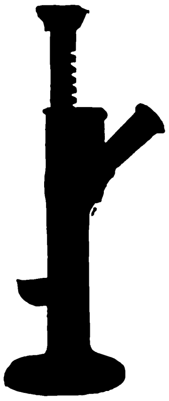
Largest Jack Manufacturers in the World

Exclusive Manufacturers of

Genuine Barrett Jacks, Barrett Mine Jacks, Ball Bearing Screw Jacks,

Duff-Bethlehem Hydraulic Jacks and Screw and Timber Braces

Dufco Mine Jacks.



No. 223

Nos. 226 and 223 are especially popular for adjusting coal cutters. There are only three simple operating parts—the machine-cut steel rack, socket lever and retaining pawl. Jack may be lowered notch by notch when under load, or may be dropped instantly when free. There are no parts to rust out or to get clogged with fine rock, grit or dirt.

No.	Capacity Tons.	Height Inches.	Raise Inches.	Weight Lbs.	List Price.
226	2½	18½	10¼	31	$18.00
223	4	22	13	44	25.00

Barrett Automatic Lowering Jacks.

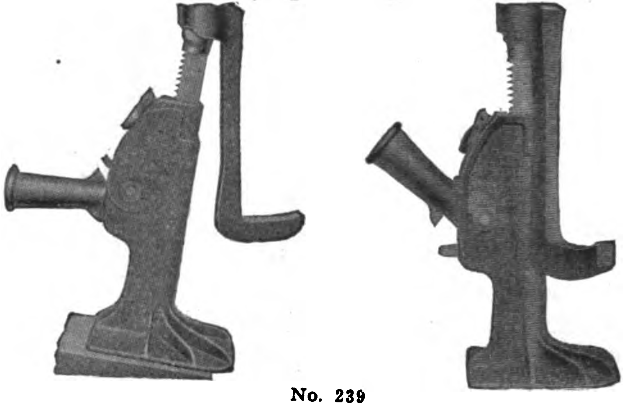
No. 2

For all around lifting purposes. These Jacks are double acting—raising the load on both upward and downward stroke of lever. They lower the load gradually. For simplicity, strength and quick, easy operation they have no equal.

No.	Capacity Tons.	Height Inches.	Raise Inches.	Weight Lbs.	List Price.
50	5	16	8	35	$16.00
51	5	21	13	42	18.00
2	10	21	10	73	25.00
3	12	26½	15	95	30.00
4	15	22	10	106	35.00
5	15	28	15	124	40.00

Barrett Emergency Car Jack.

(Single Acting)

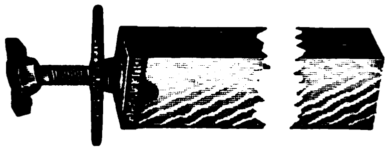


No. 239

The most powerful ratchet Jack made. Can be used in very small places. Forged steel claw swivels horizontally and vertically. Used as car and engine replacer.

No.	Capacity Tons.	Height Inches.	Raise Inches.	Weight Lbs.	List Price.
239	15	22	10½	97	$55.00

Timber Braces.



One of the Types of Timber Braces Used in Mine Shaft Work. Can Be Used Any Length from 2 to 30 Feet.

We do not furnish timbers.

Size of Screw.	Size of Cap or Washer Plate.	Weight Per Doz.	List Price Per Doz. Sets.	Tele. Code.	Butt End Caps Per Doz.
1½x14"	4x 4"	175 lbs.	$18.00	Tack	$ 3.00
1½x14"	6x 6"	192 lbs.	20.00	Tag	4.00
1½x18"	6x 6"	214 lbs.	22.00	Tank	4.00
2 x18"	6x 6"	384 lbs.	38.00	Tar	5.00
2 x18"	6x 8"	410 lbs.	40.00	Teak	7.00
2 x18"	10x10"	450 lbs.	42.00	Tenor	10.00
2 x18"	9x12"	444 lbs.	44.00	Tern	11.00

Send for Large Catalogue Illustrating Standard and Special Jacks.

THE JOYCE-CRIDLAND COMPANY

Established 1873

QUALITY

FIRST

Main Office and Works
DAYTON, OHIO

Sole Manufacturers of the

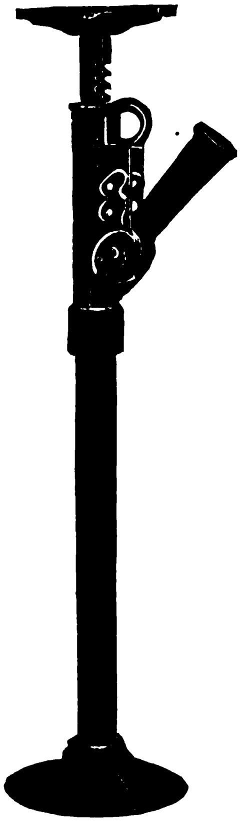
"J-C" Plain and Full Automatic Lever Jacks
"J-C" Full Automatic Geared Ratchet Jacks
"J-C" Roller Bearing Geared Screw Jacks
"J-C" Outside and Inside Pump Hydraulic Jacks

"J-C" Timbering Jack

This is a plain lever jack, specially designed for raising roof timbers in tunnels and mines. Two jacks are used at once, one being placed under each end of the timber to be raised. The jacks are then run up until the timber is in position, when uprights can be inserted and the jacks removed ready for the next timber. The frames, pawl and socket lever are made of the best grade malleable iron, the racks and pinion are of high carbon steel, having teeth carefully milled from the solid bar.

Height when down	44 inches
Rise of Bar	35 inches
Size of Bar, square	1½ inches
Weight of Jack	60 pounds
Capacity	4 tons
Price	$20.00
Code Word	Kopfgicht

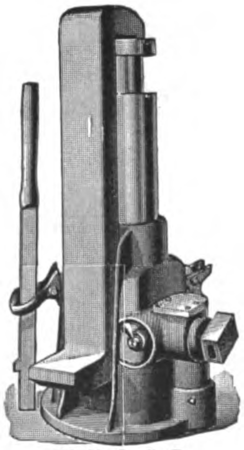
Extra run, per inch, 10 cents.



No. 32a

"J-C" Hydraulic Jacks

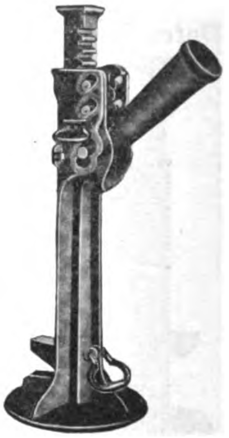
These jacks are suitable for lifting and moving heavy machines, locomotives, etc., it being possible for one man to lift a load of 200 tons with ease. They have a quick-speeding device or a double pump arrangement, making it possible to quickly run them up to load. They are also provided with a quick release so that the load can be dropped instantly if desired. They can be had with or without ground lift claw, and with any length of run in sizes up to 200 tons.



40 T. O. S. P.

"J-C" Plain Lever Jacks

This is the original "J-C" Plain Lever Jack and all patents pertaining thereto are owned by this company, none genuine unless they bear the full name of the "J-C" Company cast in frame. Nos. 2 and 4 are especially popular with the mines for adjusting cutting machines, also track and motor work. The construction is very simple, consisting of three operating parts—the machine cut steel rack, chrome nickel steel lever pinion and pawl. The jack may be lowered notch by notch when under load or may be dropped instantly when free. There are no parts to rust out or to get clogged with fine rock, grit or dirt, and are always ready for service.



No. 4

DIMENSIONS AND PRICE LIST

Jack No.	Height Inchest	Rise Inches	Size of Bar	Weight Pounds	Capacity Tons	Price
2a	18½	10	1¼	28	2	$10.00
4	22½	14	1½	40	4	16.00

A-19-JC

"J-C" Full Automatic Jacks

For all around lifting purposes. These jacks are full automatic in both raising and lowering position—single acting—raising only on the downward stroke of lever. For simplicity, strength and quick, easy operation they have no equal.

DIMENSIONS AND PRICE LIST

Jack No.	Height Inches	Rise Inches	Size of Bar	Weight Pounds	Capacity Tons	Price
66	13½	6½	1¼	33	5	$10.00
67	16	8	1¼	34	5	11.00
68	19	11	1¼	39	5	12.00
76	22¼	14¼	1½	54	10	16.00
A-19-JC	22	11	2	92	15	16.00
B-19-JC	28	17	2	100	15	18.00

TEMPLETON, KENLY AND CO., LT'D.

Established 1899

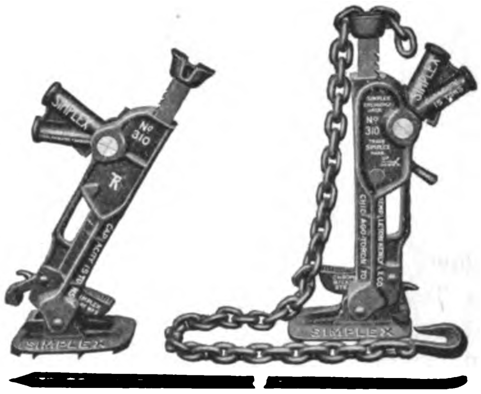
1020 South Central Ave. Chicago, Ills.

Sole Manufacturers of

Simplex Jacks

For

Mining---Industries---Contractors---Steam and Electric Railroads
Automobiles and Trucks---Telephone, Public Service and Ordnance Purposes



No. 310 Simplex Emergency Jack

Note the pivoting base—permits of jacking at any angle without the use of wedges.

The No. 310 Simplex Emergency Jack

Complete with Steel Chain, Steel Pinch Bar and Steel Detachable Shoe.

Embodies all the functions of the ordinary lifting and lowering Jack, together with the unique feature of a hinge base, making Jack operative at any angle. The only Jack made to push and lift up and out at the same time.

The No. 310 pivots on its base to any angle within 60° of the vertical. The tilting feature permits of operations impossible with any other type of Jack.

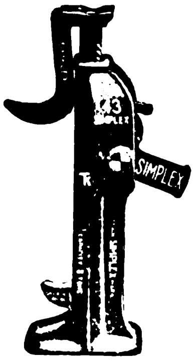
Cap swivels and is recessed to hold steel chain at any link. The two-way lever socket permits lever bar to be operated at any angle of the Jack. Heavy calks at bottom of base prevent slipping.

Construction of highest type—every working part of drop forged steel. Single acting—automatic lowering or raising. Direction of operation governed by reversing lever on side.

Specifications:

Capacity ....15 tons
Height ....21½ inches
Lift ....12½ inches

Weight, Jack ....59 lbs.
Chain ....14 lbs
Bar ....18 lbs.
Shoe .... 5 lbs.
Total Weight ....96 lbs.



No. 43 Simplex Jack

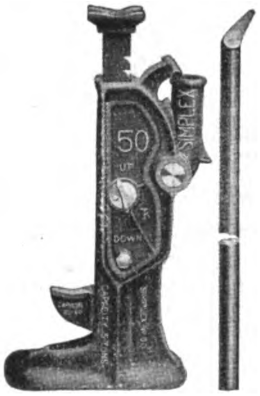
An efficient little Jack for cutting machines. Equipped with a steel grab hook which fits snugly in the cap and swings in an arc of 180° making Jack available in any awkward position. Powerfully constructed—every working part of drop forged steel.

Capacity 3 tons; Height 13 inches, Lift 10 inches, Weight 16 lbs. Complete with steel lever bar and grab hook.

No. 50 Simplex Industrial Jack

Especially designed for light cars, mining and every kind of industrial service. Operation is highly efficient and minimum effort is nectssary for the heaviest load. The pawls are interlocked—a load can never be dropped. Steel lever and pinch bar included.

Capacity 5 tons, Lift 8½ inches, Height 15½ inches, weight with bar 34 lbs.



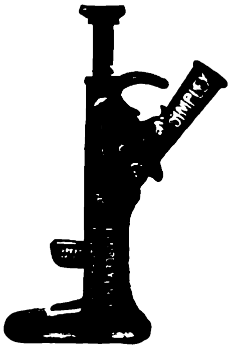
If You Believe In Safety First

The only Gold Medal for the Safety of Jack was awarded Simplex by the American Museum of Safety.

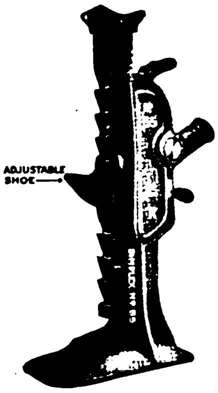
There Is a Simplex Jack for Every Purpose

Catalog describing complete line in detail cheerfully furnished.

There is a Simplex Jack for your needs.



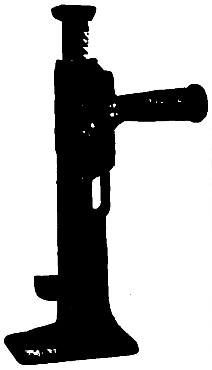
No. 1 Track



No. 55 Industrial

No. 116 Track

No. 2 Car



No. 19 Car

No. 25 Geared

IF IT'S A SIMPLEX IT'S DEPENDABLE

EDWARD F. JAMES SALES CO.

HAZLETON, PA., U. S. A.

MANUFACTURERS DIRECT AGENTS

Representing

THE ANCHOR PACKING CO.

Products

- Rubber Valves;
- Rubber Belting;
- Rexall Canvas Belting;
- Bi-lateral Fire Hose;
- Babbitt Metal;
- Pipe Covering;
- Mine Mule Collars;
- Leather Belting;
- Harness Leather;
- Graphite Products;
- Asbestos Products;
- Freeland Carbon Paint.

The illustration below is of Hoch's No. IX448 type. This is a low top mine hame, made in the Heavy Hoch Mine Pattern, made of natural root wood, bent with the grain, which adds to its strength and prevents them from becoming warped or bent. They are equipped with Hoch's patent draft attachment, with steel trace hooks, lantern hook, and Hoch lever for fastening. The lever is held by a fastener which works in a slot. The lever is so formed that no amount of pull on the traces will throw strain onto the fastener. Sizes 13 to 24 incnes.

The illustration below is Hoch's 12487 High Top Team Hame. Made of the best grade oak and ash obtainable, bent with the grain which adds to its strength, prevents it from becoming warped or bent, and saves collars from being ruined. Built especially for outside haulage and heavy lumber work.

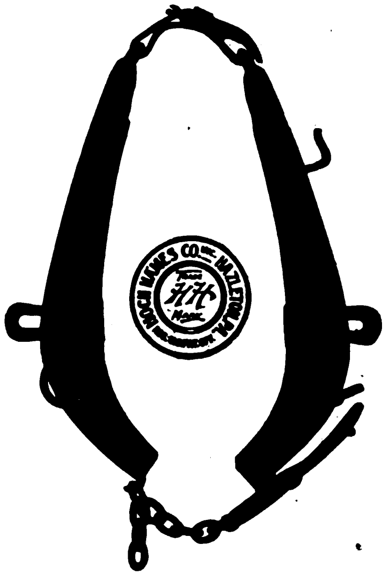
Equipped with Hoch's patent draft attachment, line rings, steel trace hooks and Hock Lever. Tops are double grooved for hame strap. Are shipped painted black and red, or black and varnished.

Sizes 17 to 24 inches.

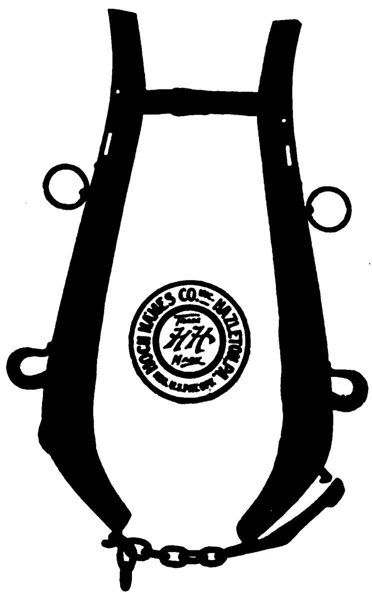
This is the illustration of No. G648 Mine Hame. It is made of natural root wood, in the heavy mine pattern. It is equipped with Hoch's patent draft attachment, steel trace hooks, lantern hook and the Smith fastening lever. The extra chain-hook plate is to be seen on the right hame. The Smith lever is made of malleable iron, and is fastened by means of a link which drops over the end when tight. The lever is so formed that it goes shut with a snap, and no amount of pull on the traces will throw strain on the fastener. Hames are varnished all over with a rain and moisture proof varnish.

Sizes 13 to 24 inches.

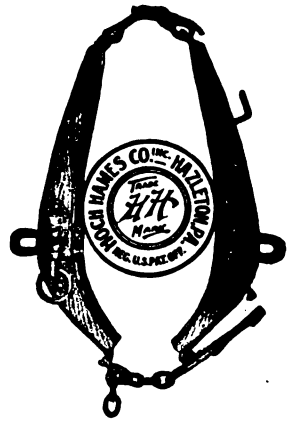
Distributors of Celebrated Hoch Hames


HOCH HAMES CO. INC. HAZLETON, PA.

No. IX448.


HOCH HAMES CO. INC. HAZLETON, PA.

No. 12487.


HOCH HAMES CO. INC. HAZLETON, PA.

G648.

Write for Descriptive Catalog.

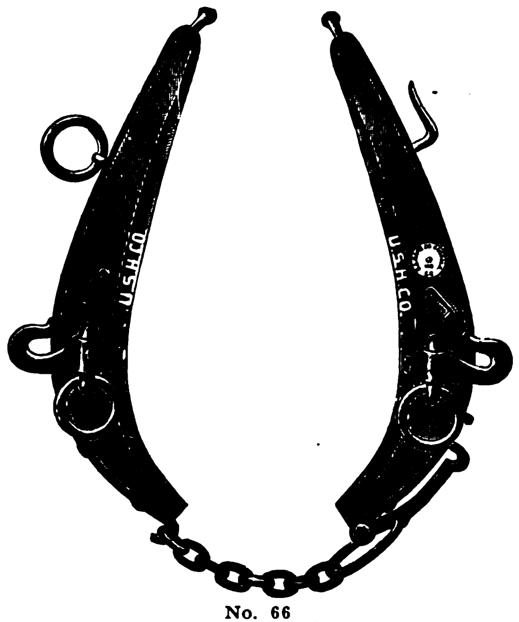
U. S. HAME COMPANY

Factory and Office
BUFFALO, N. Y., U S A.

Manufacturers of **USHCo** Hames
BRAND

Products

Mine Hames, of unexcelled quality, strength and finish.



No. 66
The Pennsylvania Pattern.

This is the strongest Mine Hame made. It is of the low top type, made of the finest timber thoroughly air dried. Our special heavy damascus black finish adds long life to every hame by keeping out mine water and moisture.

Furnished with Line Ring, Lantern Hook, and Hip Strap Staples. The fastener is the old style Pennsylvania pattern.

Furnished in sizes from 14 to 22 inches.

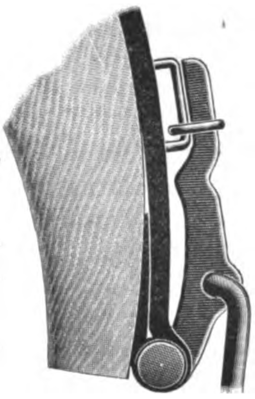
The Improved Pennsylvania Fastener

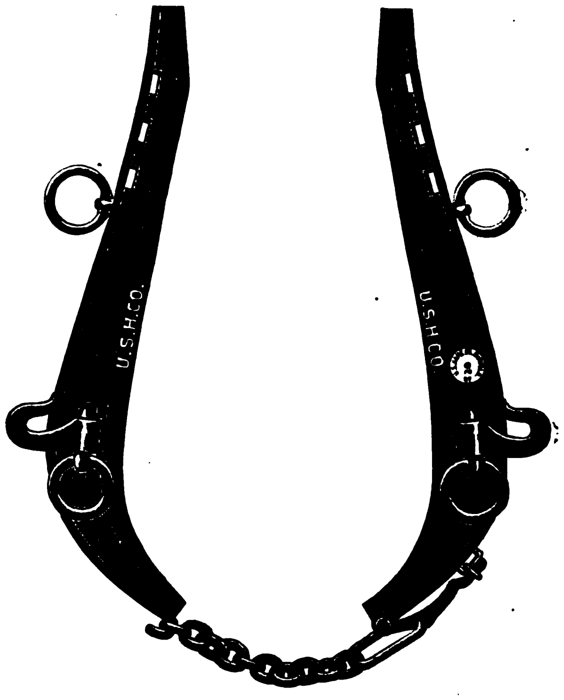
has many advantages.

There is no cutting away of wood to weaken the hame.

Fastener is all on the outside where it can be readily adjusted.

No parts to break, rust, or get out of order.




U.S.H.CO.
U.S.H.CO.

No. 67

This is a high top mine hame, made of the finest timber, thoroughly air dried. It also is finished in a heavy damascus black to protect it from moisture and mine water.

Furnished with line rings, Improved Pennsylvania Fasteners, and provided with three mortise loops for hame straps.

Furnished in three sizes: 14 to 18, 17 to 21, 20 to 24 inches.

We manufacture many other styles of Mine Hames and would suggest that you write for our catalog and have at your command a complete list of the various styles manufactured.

L. C. SMITH & BROS. TYPEWRITER CO.

Factory and Home Office,

SYRACUSE, N. Y., U. S. A.

PITTSBURGH BRANCH, 4031 JENKINS ARCADE

Products

Typewriters.

Our New Model 8 Typewriter

The New Model 8 L. C. Smith & Bros. Typewriter embodies all the features necessary to enable the operator to turn out the highest class work, whether simple letter writing or the more complex and varied forms of typewriting demanded by modern business.

Efficiency Plus Silence

Deserving special attention is the fact that the New Model 8 has certain improvements that make it the most silent running efficient typewriter ever placed on the market. Manufacturers have long striven to secure this quality of silence, but the New Model 8 comes nearer to being an absolutely silent typewriter than any other writing machine ever produced—without sacrificing any other essential features. Former models of the L. C. Smith & Bros. typewriter have been more quiet than other makes, but in the New Model 8 the manufacturers have succeeded in reducing the element of noise to a minimum.

Decimal Tabulator

In billing, tabulating, or any work involving the writing of figures in columns, the decimal tabulator saves time and secures accuracy. It is operated by five keys—the decimal, units, tens, hundreds, thousands. The tabulator stops are set, one for the decimal point in each column desired. Then, by pressing the proper key, the carriage is moved with unfailing accuracy to the writing point, so that units are placed under units, tens under tens, hundreds under hundreds, and so on. As many columns can be written on the sheet as is desired. The decimal tabulator keys are located in the keyboard between the ribbon key and back space key, easily accessible and requiring no change of the regular operating position of the hands.

The decimal tabulator is an integral, inbuilt part of every machine and is furnished at no additional cost, although other typewriter manufacturers make an extra charge for this convenience.

Variable Line Spacer

The variable line spacer, operated simply by pushing in the platen knob, enables the typist to start writing on a ruled line or a particular place on the card or sheet and to space the lines from the point of starting. It also enables the operator to write on ruled lines whose spacing does not fit the spacing of the machine.

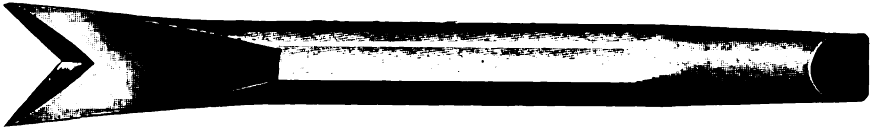
Ball Bearing Throughout

One of the most important factors in bringing about highest efficiency and service is the use of ball bearings, the L. C. Smith & Bros. typewriter being the only typewriter in which they are used at all the points where there is the most motion and where friction and wear develop if ball bearings are not used.

BURSON SUPPLY COMPANY

OFFICE AND WAREROOMS:
242-244 First Avenue
Telephones Court 3823-3824
PITTSBURGH, PA.

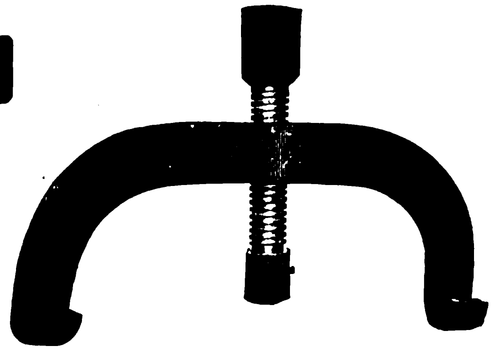
Mining Machine (Puncher) Picks



Bits and Picks are made of especially manufactured steel. These Tools are hand finished and guaranteed to be perfect. ⟶

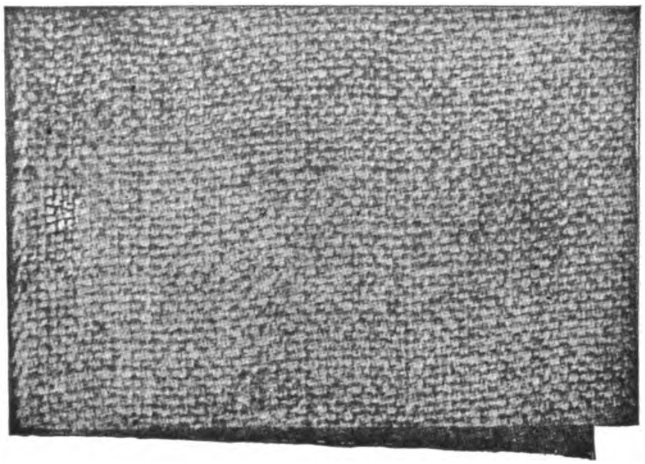
The best mover made.

"Jim Crow" Rail Benders



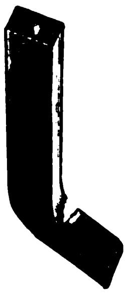
All sizes for various weight rails.

Brattice Cloth



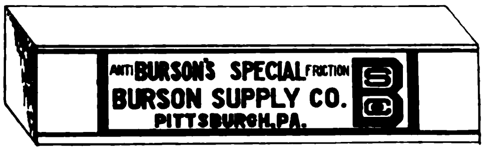
Our Brattice is heavy, closely woven (so woven as to prevent raveling) and absolutely non-inflammable. It is made from the finest quality of fibre and is coated with a preparation which preserves it from the damp of the mine—36 in., 42 in., 48 in., 60 in., 72 in. and 84 in. widths carried in stock.

Mining Machine Bits



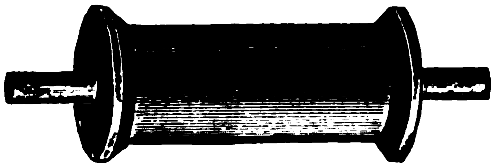
All sizes for different mining machines.

Burson Special Babbitt


ANTI BURSON'S SPECIAL FRICTION
BURSON SUPPLY CO.
PITTSBURGH, PA.

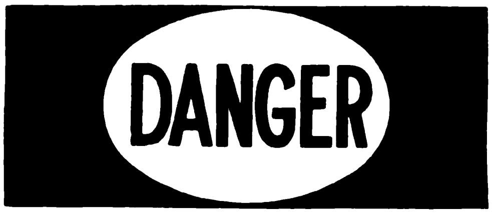
Unequaled in wearing qualities. Guaranteed best medium priced metal on the market. Furnished subject to your own trial.

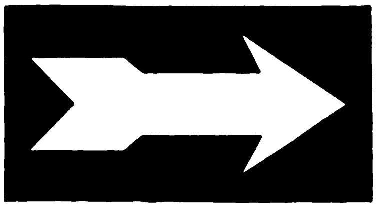
Gum Wood Rollers



For mine use. When ordering, give diameter and length and state if gudgeons are required.

BURSON'S MINE SIGNS—Approved by Department of Mines.

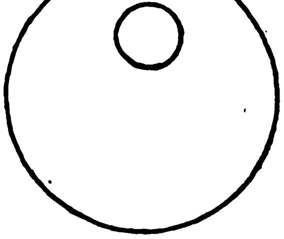




These Signs are made of heavy sheet iron. They are first coated with an acid-proof paint, have a smooth enamel finish and will last almost indefinitely. Have nail holes at top and bottom for convenience in hanging.

Danger Signs are 24 in. long and 10 in. wide. The red oval is 10 in. by 14 in., the word DANGER in white letters 4 in. high. Arrow Signs are 15 in. long and 10 in. wide.

Miners' Checks



Round, square and octagon. Will furnish plain, or numbered and lettered. The standard check is 1⅜ in. dia. and has ⅜ in. hole.

WE ARE HEADQUARTERS FOR ALL SAFETY FIRST APPLIANCES APPROVED BY THE DEPARTMENT OF MINES

Below is a Partial List of Material We Have on Hand

Anemometers
Asbestos Goods
Babbitt
Belting
Benders, Rail
Bits, Mining Machine
Blacksmith Supplies
Boiler Tubes
Boiler Trimmings
Bolts
Brattice Cloth
Brooms
Cables
Car Retarders
Checks, Miners'
Chain
Coke Oven Supplies
Compounds, Boiler
Copper Wire
Covering, Pipe
Drills
Electrical Supplies
Engineers' Supplies
Extinguishers, Fire
Fans, Mine
Fittings
Forks
Frogs
Gauges, all kinds
Greases
Ground Throws
Hardware, all kinds
Harness, etc.
Heads, Coke Scraper
Hitchings, Mine Car
Hoists
Hose, all kinds
Hydrants
Iron, all kinds
Jacks
Lamps, Miners'
Lockers, Steel
Motors
Movers, Car
Nails
Oilers
Oils
Packing, all kinds
Paints
Picks, Puncher
Pipe, Wrought Iron,
  Wrought Steel,
  Cast Iron
  and Wood
Pumps, all kinds
Radiation
Rails
Rollers, Wood
Roofing, all kinds
Rope, all kinds
Splice Bars
Steel, all kinds
Rubber Goods, all kinds
Replacers, Car
Safety First Material
Salamanders
Sand Dryers
Scales
Screens, Perforated
Shoes, Horse & Mule
Shovels
Sheaves, Mine
Signs, Mine
Spikes
Stoves
Switches
Tanks, Wood & Steel
Tires, Automobile
Tools, all kinds
Transmission Goods
Valves
Washers
Waste
Wheels, Trolley
Wheelbarrows
Wire, all kinds

STOCK SHIPMENTS— FAIR PRICES

ALL KINDS OF SUPPLIES FOR THE MINE

H. L. CHILDS & CO.

INC.

PITTSBURGH, PA.

Bell Phones 122-123 Court

Established 1877

Mill and Mine Supplies

Products

Mill and Mine Supplies.

Non-inflammable Brattice Cloth, Cotton Rubber Lined and Underwriters' Linen Fire Hose; Rubber, Canvas and Leather Belting; Air, Steam and Water Hose; Hydraulic and Steam Packings; Cotton and Wool Waste; Alligator Steel Lacing; Puncher Picks and Machine Bits; Fire Extinguishers; Boiler Graphite, etc.

Brattice Cloth

We are large importers of Brattice Cloth.

All our Brattice Cloth is fireproofed by a chemical process, is absolutely non-inflammable, and will not rot as quickly as other cloths, or unravel.

"M. U. N." brand, is a very close-woven Jute non-inflammable Brattice Cloth, which allows only a very small amout of air to pass through it.

"E. G. C." brand, is a heavy Jute non-inflammable Brattice Cloth, made from a very strong double warp and durable thread, a cheaper cloth, but of high quality.

"H. L. C." brand, is a high grade non-inflammable Twilled Brattice Cloth.

Large stock of all widths and grades carried.

Samples and prices sent upon request.

Hose

Water, Steam, Air Drill and Suction Hose.

We carry a complete stock of the different sizes and grades of Hose. Write us for samples and prices.

Fire Hose

Cotton Rubber Lined and Underwriters' Linen Hose.

Our Fire Hose is absolutely guaranteed to stand required pressures, and our Underwriters' Linen Hose bears the Underwriters' Laboratories Labels.

Leather Belting

"BESSEMER" brand, oak tanned.

Double and single ply Leather Belt, made with short lap and from heavy center stock.

Rubber Belting

"BESSEMER" brand, weight 32 oz. Duck.

This Belt has a high friction, is extremely flexible, and is adapted for either driving or conveying purposes.

Canvas Belting

"GANDY" Belting.

We are the sole agents in this territory for the famous "Gandy" Canvas Stitched Belt, made from 33 oz. Duck. We have been handling this belt for 30 years. The "Gandy" Belt has an "Imbedded Stitch," which holds the plies of the belt solidly together and making the surface of the belt smooth. This belt is also saturated in a compound of purest oils, making it water, steam and heat-proof.

All sizes and weights carried in stock.

Waste

We carry a large stock of all grades of white and colored Cotton Waste and Wool Waste.

Can give you any grade, from a cheap colored Waste for rough work for a few cents a pound, to a high grade fancy white polishing Waste for automobile owners and engine rooms.

All our Waste has long fibre and is absolutely clean and free from foreign substances of any kind.

Boiler Graphite—85% Pure

Our Boiler Graphite is a most perfect material to mechanically and gently loosen and remove scale in boilers. Because of its mechanical action, it works equally well in any kind of feed water. It is the highest grade of natural amorphous Graphite that can be produced and has absolutely no effect upon the metal of the boiler, as many of the commonly called Boiler Compounds have. Our Boiler Graphite is not soluble in water and, therefore, will not carry out with the steam, as do most chemically acting boiler compounds. We carry this in 100 lb. kegs and 400 lb. barrels.

"Alligator" Steel Lacing

For machinery belting.

This is a modern Lace for leather, rubber, balata and cotton or canvas stitched belting. A separable lacing, hinging on a rawhide or sectional steel rocker pin.

To attach this Lacing to a belt no tool is required but a hammer.

It will work perfectly with an idler.

No punched holes, which weaken a belt, are required.

"Alligator" Lacing is suited to exceptional requirements as well as the ordinary run of factory work; in many cases making a satisfactory joint where all other kinds of fastenings have failed to meet conditions. We carry a large stock of all sizes.

Let us send you a sample box free of charge.

Mining Machine Bits and Puncher Picks

We manufacture our own Machine Bits from the finest high carbon steel, any length, size or shape you may require, with either chisel or pick points.

We have a large stock of Puncher Picks, which are made to fit any machine. They are tempered and drawn, which makes them very tough.

A trial order will prove our statement.

Packings

We carry a large stock of all kinds of Rubber, Hydraulic and High Pressure Packings.

"Childs" Fire Extinguisher

Capacity 3 gallons.

Our Hand Chemical Fire Extinguisher is made under the supervision of the Underwriters' Laboratories, Inc. This extinguisher is brass and of exceptionally fine finish, and contains a chemical that has proven to be forty times as efficient as water and will extinguish fires of oil, naphtha, gasolene, etc.

COLONIAL SUPPLY CO.

OFFICE AND SALES ROOMS

412-414 First Avenue

Bell Phones, 1043-1044 Court. P. & A., 1870 Main.

PITTSBURGH, PA

"Everything for the Mine"

Products

- Anvils
- Asbestos Goods
- Augers
- Automobile Supplies
- Axles
- Babbitt
- Balata Belting
- Barrows
- Bars
- Bellows
- Bells
- Belting
- Benders
- Bibbs
- Bits—Mining Machine
- Blacksmith Supplies
- Blocks
- Boiler Tubes
- Boiler Trimmings
- Boilers
- Bolts
- Brass Checks
- Brass Goods
- Brattice—See page 796
- Brooms
- Brushes
- Buckets
- Builders' Supplies
- Burners
- Cables
- Cans
- Cars
- Carts
- Castings
- Cement
- Chain
- Chemicals
- Chalk
- Checks—Brass
- Chucks
- Clamps
- Clips
- Clocks
- Cocks
- Coke Oven Supplies
- Contracts Supplies
- Copper
- Cots
- Drills
- Duck
- Dynamite
- Electrical Supplies
- Elevator Buckets
- Emery
- Emery Wheels
- Emery Paper
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- Engineers' Supplies
- Expanders
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- Fans—Mine
- Fans—Electric
- Farriers' Tools
- Fence
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- Nipples
- Nuts
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- Oilers
- Oiling Devices
- Oils
- Packing—All Kinds
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- Paints
- Paper
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- Pliers
- Plows
- Plumbing Supplies
- Pulleys
- Pumps—All Kinds
- Rags—Wiping
- Rail Benders
- Railroad Supplies
- Ratchets
- Rawhide
- Reamers
- Recording Cages
- Rollers—Wood
- Roofing—All Kinds
- Rope—Manila
- Rope—Wire
- Rope—All Kinds
- Rosin
- Rubber Goods of All Kinds
- Safety First Supplies
- Saws—All Kinds
- Salamanders
- Sand Driers
- Screw Plates
- Scraper Heads
- Separators
- Shafting
- Shovels
- Signals
- Signs
- Sisal
- Sledges
- Spikes
- Smoothon
- Stable Fittings
- Steam Traps
- Steel Goods
- Shoes—Horse all kinds, Mule
- Stock and Dies
- Stoves
- Switches
- Tackles
- Tanks—All Kinds
- Tapes
- Taps
- Tents
- Thermometers
- Tools—All Kinds
- Torches
- Track Tools
- Transmission Goods
- Trolleys
- Trucks
- Tubes
- Tubing—All Kinds
- Turnbuckles
- Unions—Mark
- Valves—All Kinds
- Wagon Supplies
- Washers
- Waste—All Kinds
- Waste Cans
- Wheelbarrows
- Wheels
- Whistles
- Wire—All Kinds
- Woodworkers' Tools
- Wrenches—All Kinds

A Lot of Good Things Every Month

Will come your way if you have your name on the mailing list of THE COLONIAL SOLDIER, the monthly house organ of the Colonial Supply Company.

Sent free of cost upon request and is a valuable aid to your business. Keeps you posted on the latest Mine and Mill Supplies and tells you the market news.

If it is not reaching you regularly, ask us about it. We want you to have the benefit of this monthly news bulletin.

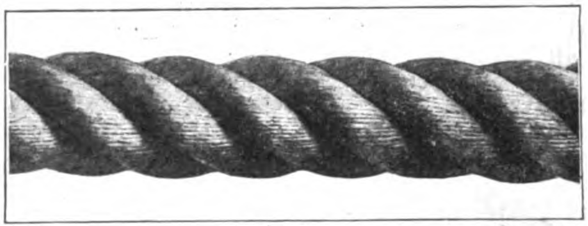
Keep in touch with us through the columns of The Colonial Soldier. Write for it today.

Souvenir will be sent for the sending of your name and address.

Colonial Manila Transmission Rope

There is an ever increasing demand for Rope for the transmission of power. So important is the use that quality dare not be neglected.

In buying "Colonial" you are sure of the Greatest Amount of Power Transmission, Smooth and Quiet Running in Any Direction, Freedom from Electrical Disturbances, Economy in First Cost and in Maintenance. Accurate alignment of sheaves unnecessary.

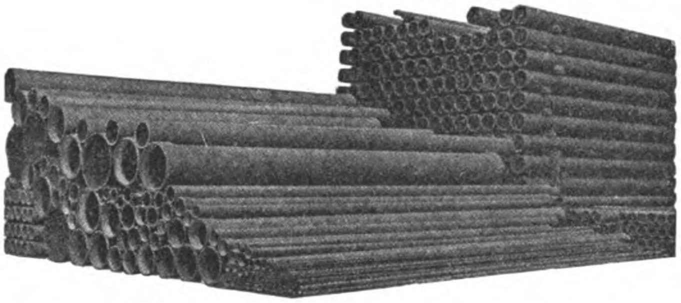


All of our Ropes and Cordage save you time and expense.

COLONIAL SUPPLY CO.

Piping and Tubing

All your wants supplied in any size or length of standard sizes and gauges. Also, special gauges or special bent tubes furnished promptly as ordered.

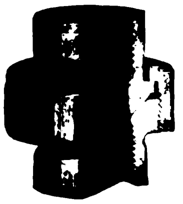


We ship from our large stocks at Mill Discounts, Wrought Iron and Steel Pipe, Wrought Iron and Steel Tubing, Wrought Iron and Steel Line Pipe, Lap Welded Steel Boiler Tubes, Lap Welded Charcoal Boiler Tubes, Seamless Steel Boiler Tubes, Pure Copper Boiler Tube Ferrules (all sizes). Also Mild Open Hearth, Lap Welded "Perfect" Seamless Cold or Hot Drawn Steel Tubes and Tyler Tubes.

Pipe Cut to Order

Our facilities are unsurpassed for Cutting and Threading pipe of any size to your blue print or sketch. We are prepared to install and erect piping.

Quality and Service are first considerations in our dealings with all our customers. We care for your requirements quickly, with better piping and tubes than the same money will buy anywhere else.



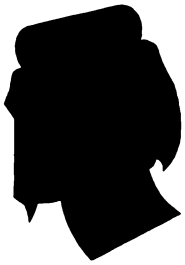
The Mark Cold Drawn Steel Union

Best Union for all Pressures.
Only Union for High Pressure.
Stronger than the Pipe.

Being made of drawn steel it expands or contracts with the pipe. Has no blow-holes or other imperfections. Cannot leak, cannot corrode, cannot rust. Its long life gives the greatest length of service and makes the Mark Union the cheapest as well as the best of all.

PACKING

N. B. O. the Original Black Sheet.



This is the proved and accepted Packing for withstanding Oil, Acid, Alkali, Ammonia and Steam action. Comes plain, with wire cloth, or with Asbestos Insertion. Also made in ring or gasket, flat or tubular, or moulded to design. Weighs less per square yard than any other Packing.

Colonial Diagonal Packing

The Packing for Steam Piston, Ammonia and Hot Water Pumps. Made in coil, spiral or ring form, for high and low pressures.

Regular — Recommended for pressures up to 100 pounds.

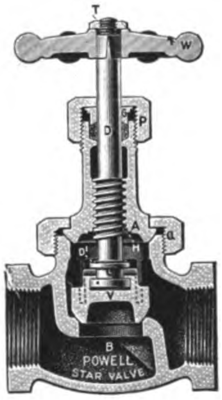
Special — Recommended for pressures over 100 pounds.

You will like Colonial Guaranteed Red Sheet Packing.

Colonial Packings are put up in air tight tin boxes, which give thorough protection from atmospheric action, grit and other foreign matter.

All kinds carried in stock. Quick service at prices that will save you money.

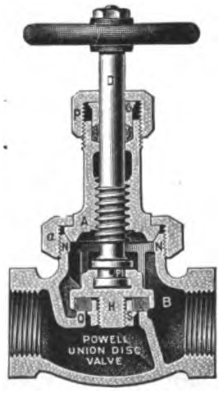
VALVES



Model Star.

The perfection of Powell Valves for all mining purposes is the only recommendation needed to those who have used them and know their worth.

The "Model Star" is made in sizes $1/4''$ to $4''$ inclusive, medium and extra heavy patterns, screwed or flanged end. Globe, Angle, Cross and Check Valves.

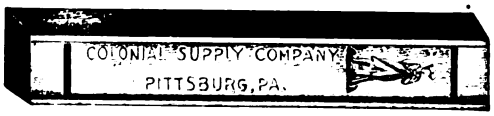


Union Disc.

The "Union Composite" is a disc valve made along the same lines as the "Model Star". It has the "Union" Bonnet Connection, Swivel Disc Holder which will retain any make of Rubber Discs and will stand most severe test under any conditions.

We carry in stock all sizes and patterns of both these valves and are prepared to make quick shipments.

COLONIAL ANTI-FRICTION BABBITT METAL



Our trade mark is its guarantee of quality. Furnished subject to your own trial.

Pours easier, wears longer and gives better all around satisfaction than any other Babbitt on the market.

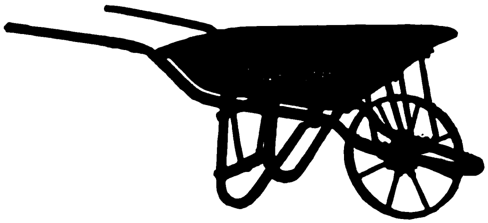
Don't Risk Shut-Downs

Often they are caused by the use of imperfect and impure bearing metals. Scrap mixtures are not cheap when they contain impurities which work mischief by causing interference with operations.

Colonial Anti-Friction Babbitt Metal is strong, tough and suitable for any service.

Get further particulars from us. You must be satisfied with your order or no sale is made.

Coal and Coke Wheelbarrows



Made entirely of Steel and Iron.

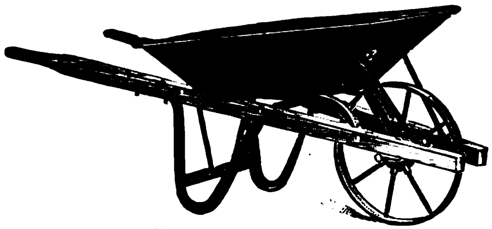
Coal and Coke Barrow.

The Never-Break Wheel is right Under the load.

The Frames are built of Tubular Steel bent so as to form the legs and handles all in one piece, and these are held together by heavy Iron Straps and bolted to the bottom of the Tray.

The Tray itself is stamped out of one sheet of heavy gauge steel and is especially adapted for hauling heavy castings, iron ore and the like.

Here is the Best Concrete Barrow



Concrete Barrow.

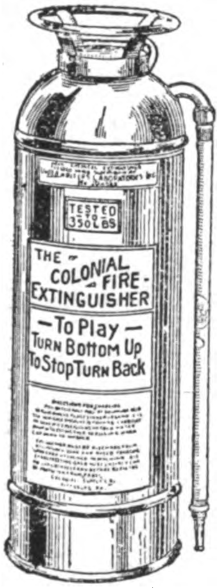
Equipped with wheel guard which permits of forward dumping. Note the angle iron raisers underneath the tray, which elevate the front end of tray so that, in wheeling, the tray stands level, preventing the load from slushing over in the front. Equipped with angle iron cross pieces. Capacity 4 cu. ft. Weight 65 lbs. each.

FIRE PREVENTION APPARATUS AND APPLIANCES OF ALL KINDS.

We have made a special study of devices and supplies for fire protection, and solicit correspondence on any equipment or outfits for large or small buildings, institutions, etc. Will be pleased to draft plans and specifications for installation. This service of our Experts is free.

Products

Fire Hose, Pyrene Extinguishers, Chemical Engines, Hydrants, Non-Explosive Gasoline Cans, Colonial Chemical Extinguishers, J-M Fire Extinguishers, Underwriters' Approved Devices of All Kinds, Watchman Clocks, Hose Racks, Hose Reels, Fire Plugs, Ladders, Fire Escapes.



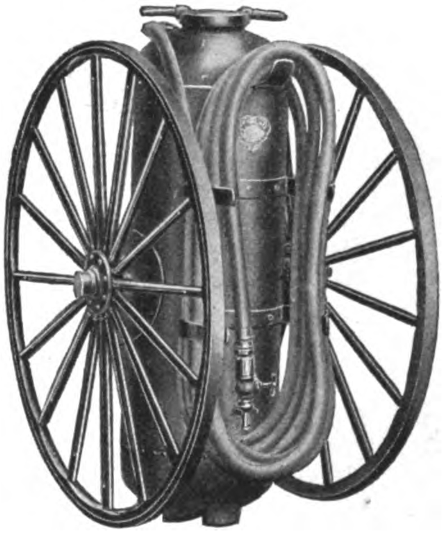
Colonial Fire Extinguisher

Tested by Underwriters' Laboratories (Inc.), under the direction of the National Board of Fire Underwriters. An extinguisher with so much worth and quality that we have no hesitancy in giving it our own name. Price, each **$12.00**

PYRENE Extinguishers are filled, ready for use. Prices are f. o. b. New York City, or nearest shipping point.

Prices

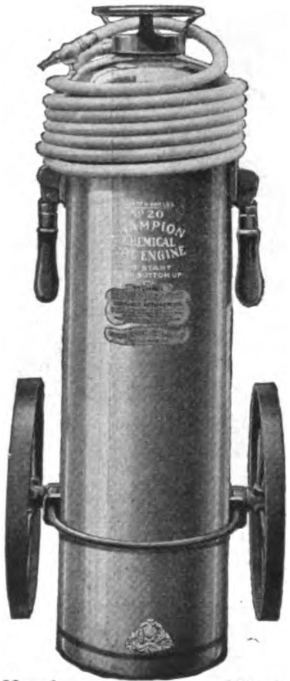
Brass Extinguisher..	**$10.00**
Bracket, Enamel Finish	.50
Bracket, Brass Finish.	.75
Bracket, Nickel-Plated Finish	1.00
Liquid, per gallon.....	5.00



Number 27. Price, $185.00.

CAPACITY—40 gallons. Weight—380.
WIDTH—Over all, 23⅞ inches.
LENGTH—Over all, 49 inches.
HEIGHT—Over all, 52 inches.
GAUGE or TREAD—27 inches.

Sold 30 Days Free Trial.



Number [illegible] Price, $75.00.
Capacity, 20 gallons.
Weight (empty), 135 lbs.
Weight (charged and ready for use), 300 lbs.
Width (over all), 22 inches.
Height (over all), 48 inches.
Is furnished with 25 feet special chemical hose with brass couplings and shut-off nozzle attached.

Sold 30 Days Free Trial

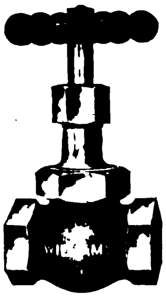
WRITE FOR DISCOUNTS.

FRICK AND LINDSAY COMPANY

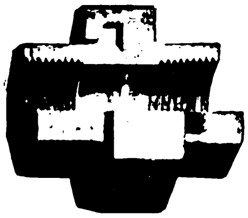
P. & A. Telephone 700 North

PITTSBURGH, PA.

Telephone 3180 Cedar



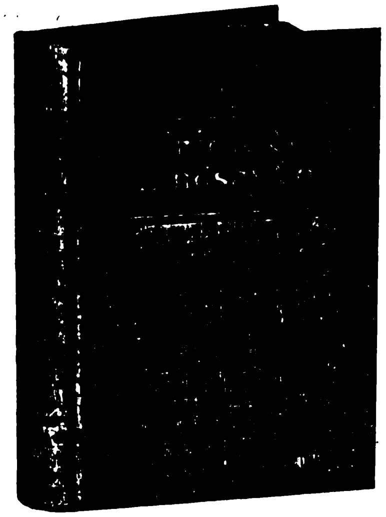
Williams Regrinding Valves—Perfect for mine use.



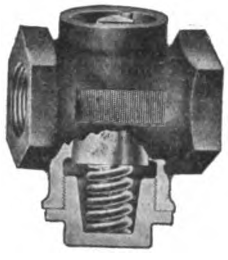
Superior Brass-Seat Ground-Joint Unions—Strong, safe and durable.
No gasket required.

Jeffrey Chain Belting and Transmission Materials of all kinds in stock; Pulleys, Hangers, Shafting, Etc.

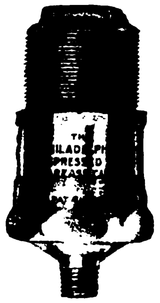
A Fine Modern Catalog of Mine Supplies and Specialties



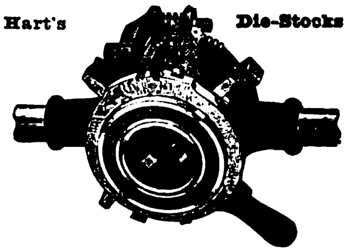
Supplied to Our Patrons.



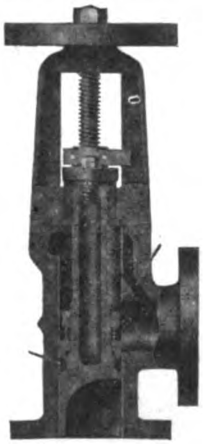
Special Lock Shield Mine Air Cocks; Pipe, Valves and Fittings of all kinds. For mine use.



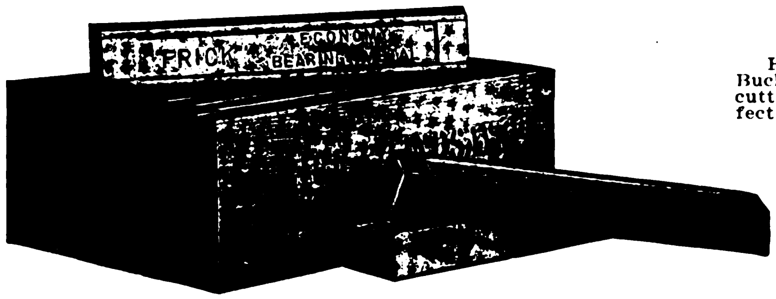
The Philadelphia Compressed Air Grease Cup—Solves all lubricating problems. Simple and automatic.



Hart's Famous Duplex and Buckeye Die Stocks—Fast, easy-cutting, clean-threading—the perfect modern pipe tool.

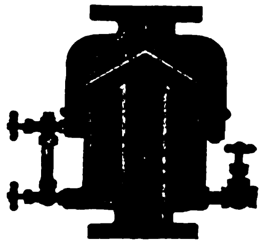


Schiller Seatless Balanced Blow-Off Valve. Guaranteed to end Blow-Off Troubles.

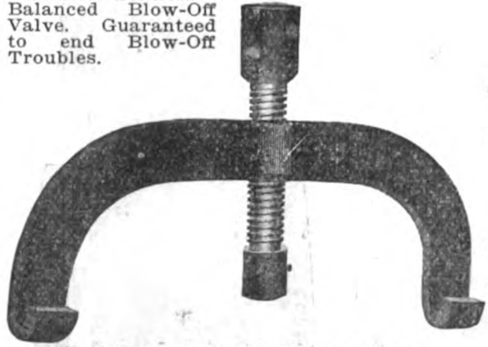


Babbitt Metal—An exclusive and highly successful specialty line. Two leading Brands at just prices; "Frick Economy" & "Superior."

"Superior" and "Standard" Picks carried in stock.

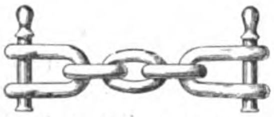


Cookson Seperators—Horizontal or Vertical—Moderate price—efficient. Also Cookson Steam Traps.



All styles and sizes. Quick deliveries.

Machine Bits, Finished or Blank. All styles & grades. Prompt shipments.

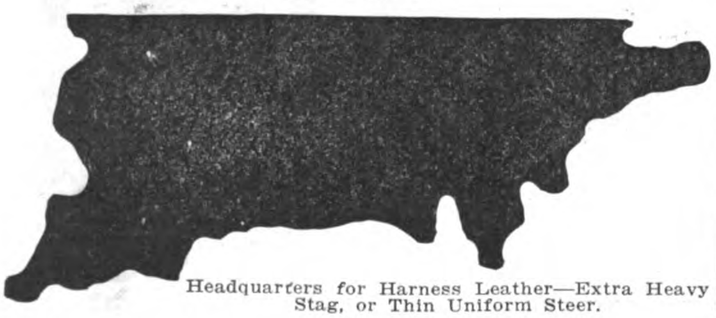


Mine Car Hitchings. Regular and Bell-clevis.

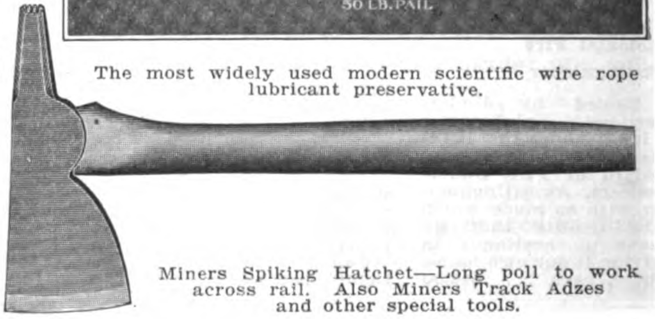
WIRE ROPE LUBRICATOR.

10 LB. CAN
HALF BARREL
BARREL
50 LB. PAIL
WIRE ROPE LUBRICATING CO No 1 LUBRICATOR
WIRE ROPE LUBRICATING CO No. 1 LUBRICATOR

The most widely used modern scientific wire rope lubricant preservative.



Headquarters for Harness Leather—Extra Heavy Stag, or Thin Uniform Steer.



Miners Spiking Hatchet—Long poll to work across rail. Also Miners Track Adzes and other special tools.

"Superior" Shovels. Nothing better on the market.

The Famous IXL Safety Wrench

One man opens and closes drop-bottom gates. In universal demand.

The only safe, successful, quick-acting, steel hopper CAR WRENCH.

FRICK & LINDSAY CO., Distributors.

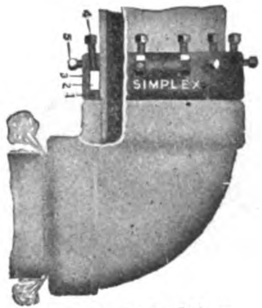
Mining Machine Air Hose a specialty. "Superior" Steam Hose, the equal of anything made.

USE SUPERIOR ROOFING

STAND ON END
SUPERIOR
The Best That Can Be Made
F&L Co
DURABLE - ECONOMICAL - FIRE-RESISTING
ROOFING
USE NO HOOKS

TO BE ABSOLUTELY CERTAIN

Canvas, Rubber, Balata and Leather Belting.

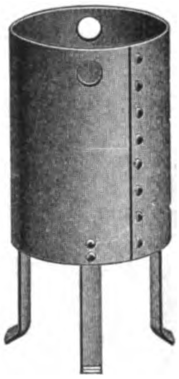


Simplex and Other Emergency Steam Repair Clamps.

Car Movers—Leading Makes.

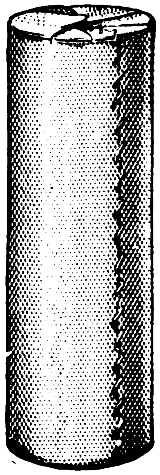
The Famous SAMPSON Car
Extra Heavy SAMPSON Locomotive
The Atlas, etc.

The Famous Mine Rope.

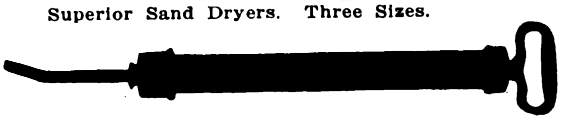


Salamanders for heating offices, warehouses, etc.

Superior Sand Dryers. Three Sizes.



Brattice Cloth, Jute and Duck.



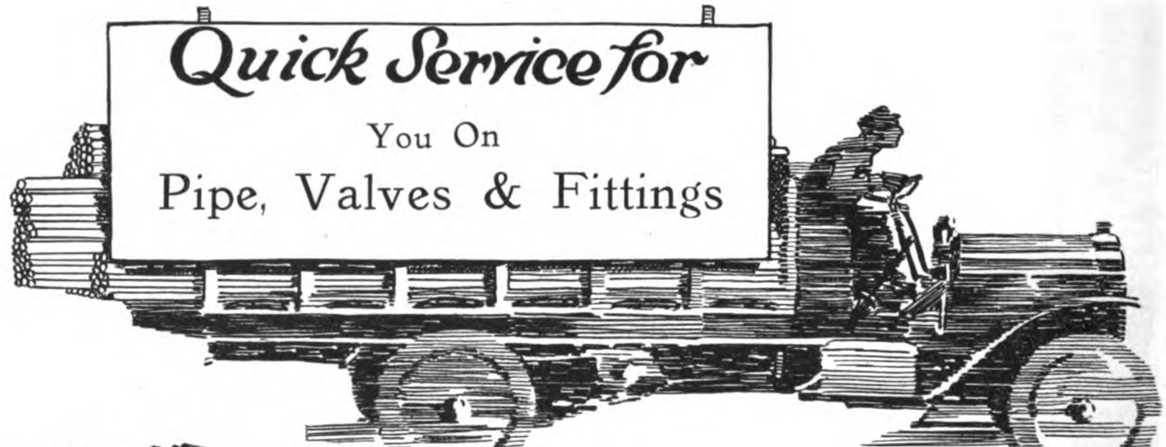
Improved Heavy Brass Mine Car Oiler or Grease Gun. Very powerful.

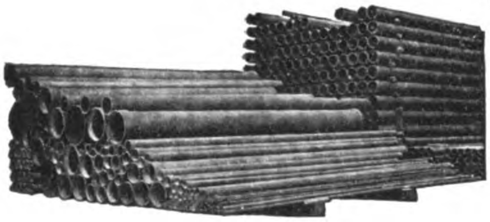
Kilbourne & Jacobs All-Steel and Wood-Frame Barrows.

HARRIS PUMP & SUPPLY CO.

320-322 Second Ave. PITTSBURGH, PA.

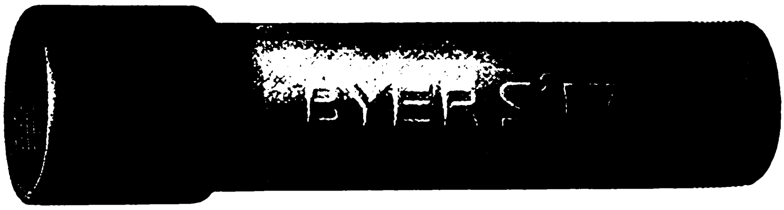
Pumps and Hydarulic Machinery





Pipes, Valves and Fittings

We are one of the largest distributors of wrought iron and steel pipe in the Pittsburgh District, carrying in our Pittsburgh stock, also in our Warehouse, approximately twenty-five cars at all times, running in sizes from ⅜" to 12", so as to enable prompt deliveries to our customers.



Cut Pipe to Order

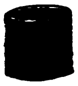
We have facilities for cutting and threading pipe of all sizes from your blue prints or sketch.

Valves

We have in Pittsburgh stock a very complete line of all types of valves from smallest to largest size for immediate shipment, especially those most in demand for Coal Mine Service. Valves in brass, iron body and cast iron for all pressures and all purposes. Gate valves, check valves and rubber pump valves.

Our Brown Colis Rubber Valve is one of the best on the market today, and is greatly in demand.

We would be very much pleased to have your inquiry for this class of material.



SEE PAGES 560 TO 567 AND 578, DEMING & MORRIS PUMPS IN STOCK AT PITTSBURGH FOR IMMEDIATE SHIPMENT

Railway and Mine Supply Company

General Offices
McCormick Building, Chicago Ill

Factory and Warehouses
KINCAID, ILLINOIS

"Everything Used In a Coal Mine"

Accident Cabinets;
Anvils;
Babbit;
Beams;
Belting;
Benders, Rail;
Blowers;
Boilers;
Bits, Mining Machine;
Bit Steel;
Boiler Tubes;
Boiler Trimmings;
Bolts;
Brass Goods;
Cans;
Cars, Mine;
Drills;
Dynamite;
Electrical Supplies;
Emery Wheels;
Emery Paper;
Engines;
Expanders;
Explosives:
  Blasting Powder,
  Dynamite,
  "Franklinite" Permissible
  Fuse,
  Caps,
  Exploders,
  Miscellaneous Supplies;
Hammers, Hand;
Hammers, Power;
Headlights;
Hoists;
Hose;
Hitchings;
Leather;
Lamps;
Lathes;
Lubricators;
Machinery;
Motors;
Nails;
Nuts;
Packings;
Paper, Blasting;
Pipe and Fittings;
Pulleys;
Pumps;
Rail Benders;
Railroad Supplies;
Roofing;
Rope, Wire and Manilla;
Shafting;
Shovels;
Sledges;
Spikes, Track;
Shoes, Horse and Mule;
Stocks and Dies;
Tanks;
Tools, Track;
Trolley Wheels;
Valves;
Washers;
Waste;
Wire;
Woodworking Machinery.

Pit Cars

We have our own factory and are equipped to turn out Mine Cars of all kinds; Mine Car Wheels; Mining Machine Repair Parts; Locomotive Repair Parts, Etc.

We manufacture Gray Iron, Semi Steel and Brass Castings.

Brattice Cloth

Our "R M S" No. 12 Brand is a superior quality, closely woven, non-inflammable Jute Cloth, which we recommend as the most satisfactory medium priced cloth on the market.

Second Hand Machinery

We have listed at all times a large stock of second hand machinery and equipment. If you are in need of anything or have anything for sale in this line communicate with us.

Rails

We carry in stock a large supply of New and Relaying Rails.

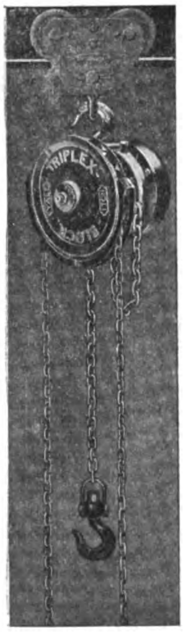
THE SCALLAN SUPPLY CO.

CINCINNATI

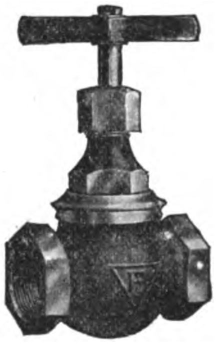
Mine Supplies

"Buy From Scallan

Asbestos Goods
Babbitt Metal
Barrows
Belting, all kinds
Blocks, Yale & Towne
Bolts
Brooms
Buckets
Cans, Safety
Carts
Cement
Contractors' Supplies
Drills
Emery
Emery Wheels
Extinguishers, Fire
Files
Filters, White Star
Fittings
Glue
Graphite
Hack Saw Blades
Hammers
Handles
Hangers, Shaft
Hoists
Hose
Jacks
Lace Leather
Lamps, Cap
Lanterns
Lathes
Nails
Nuts
Oilers
Packing
Picks
Pipe
Pulleys
Rags
Ratchets
Reamers
Rope
Rubber Goods
Saws
Screw Plates
Shafting
Shovels
Sledges
Sprayors
Steam Traps
Taps
Torches
Trolleys
Trucks
Unions
Valves
Washers
Waste
Waste Cans
Wheelbarrows
Wire
Wrenches, Coe's
Wrenches, Pipe, Etc.

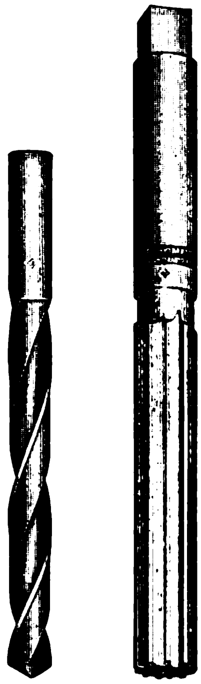


Yale & Towne Triplex, Duplex, Differential and Electric Hoists, Trolleys, Track, etc. Complete stock of all sizes for immediate shipment.

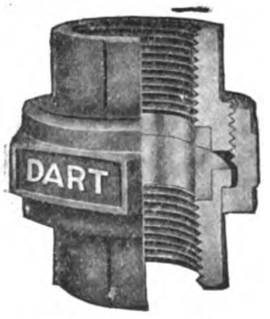


Fairbanks Valves. Asbestos Packed Cocks. Complete stock. See page 275 this Catalogue.

Files.



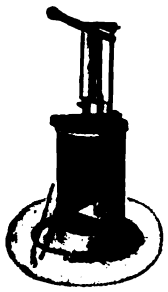
Cleveland Drills and Reamers are well known by all mechanics. We carry complete stock of all sizes.



Dart Unions—you know them. Large stock, all sizes.

Fire Appliances of All Knds. Hose, Racks, Cans, Etc.

"Brite-Lite" Cap Lamps. The Modern, Up-to-date Lamp No Troubles.



Paragon Sprayers. All sizes in stock. Ask for Catalogue.

ASK FOR SPECIAL CATALOGUES

The Standard Sanitary Manufacturing Co.

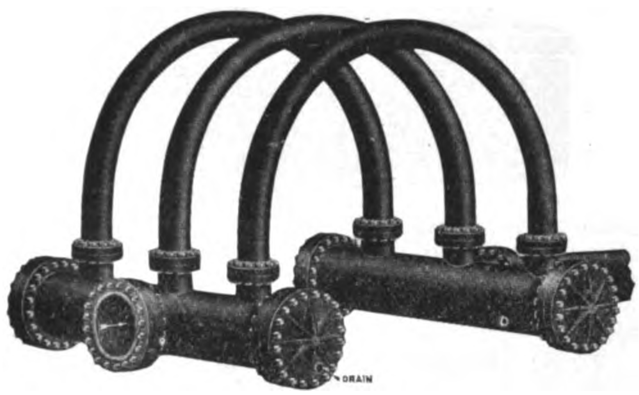
STANDARD DIVISION

439 WATER STREET PITTSBURGH, PA.

Branch Stores:

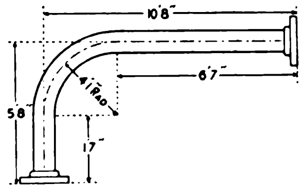
COLUMBUS, OHIO
YOUNGSTOWN, OHIO
ALTOONA, PA.
WHEELING, W. VA.

Plumbing and Power Equipment
Steam Specialties and Mine Pumps

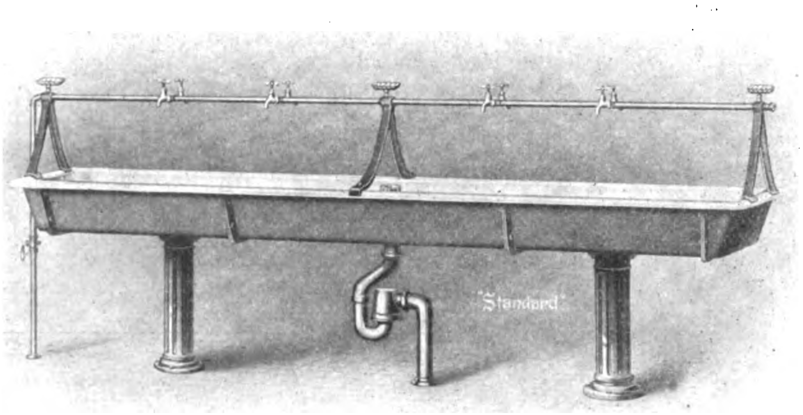


We are the largest manufacturers in the world of Complete Plumbing Equipments for Factories, Mines, Offices and Residences. Our representatives assist you in designing your requirements. Complete stocks of plumbing material are carried in all Branch Stores.

We specialize in Pipe Cut to Sketch, Pipe Bends and Welded Headers and carry a complete stock of Iron and Steel Pipe, Brass Pipe Valves, Screwed and Flanged Fittings up to 12" diameter.



Please note that there are five dimensions which are necessary to enable us to quote prices on Bends.



This Wash Sink is absolutely the most Sanitary Sink on the market, and is designed to utilize a very small amount of floor space, compared with other Wash Sinks. Single or double, in 18" wide, 24" wide and 27" wide; 26 inches or 31 inches from floor to top of rim, and in lengths of 3 feet to 66 feet inclusive. These sinks are made with enameled interior and painted exterior. Nickel Plated Hot and Cold Water China Indexed Faucets are also furnished. The name, **Standard,** insures Quality.

OUR MOTTO: "SERVICE FIRST"

C. A. TURNER INCORPORATED

Established 1880 Incorporated 1906

Storage Warehouses
Nos. 34, 36, 38, 40, 42 & 48
Pittsburgh Terminal Warehouses
Bell 'Phone, Hemlock 639-J

Office, Salesroom and Warehouses
Third Ave. & Chancery Lane
PITTSBURGH, PA.
'Phones { Bell, Court 721
P. & A., Main 562

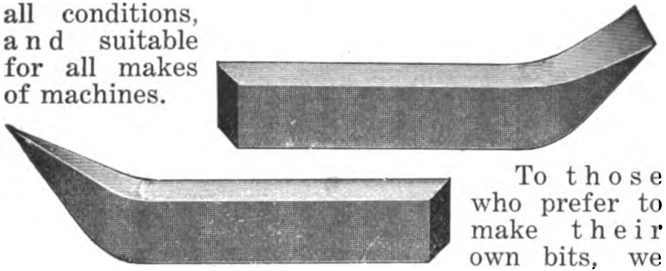
Forge Shop
111, 113, 115 & 117 Water St.
Machine Shop
84, 86 First Ave.
'Phones { Bell, Court 2826
P. & A., Main 420

Manufacturers of

Mine and Mill Supplies

Mining Machine Bits

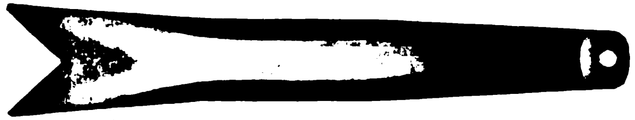
We are the largest manufacturers of mining machine bits in the country. Made of our Special Analysis Steel and guaranteed satisfactory under all conditions, and suitable for all makes of machines.



To those who prefer to make their own bits, we can supply our special steel in bars or cut to any length desired.

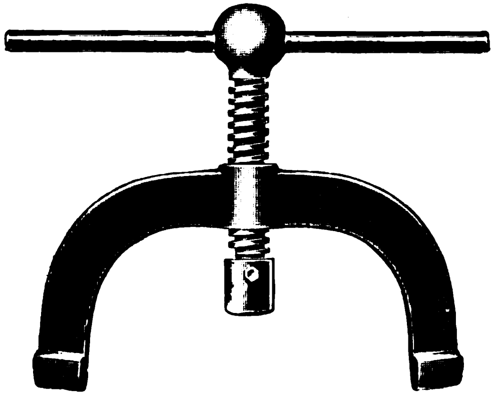
Puncher Picks

Our Puncher Picks, like our Bits, are made in our own shop and of our Special Analysis Steel. For exceptional hard cutting we can make these of Tool Steel.



"Jim Crow" Rail Benders

Made of best open hearth steel. Screw has machine cut square threads.



Can also furnish with a ratchet if desired. Made for from 16 to 100 lb. rail.

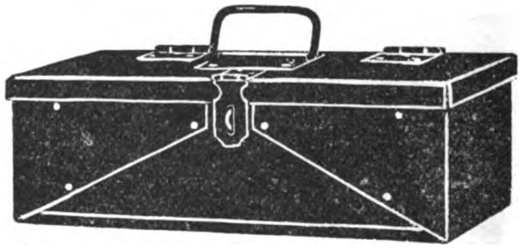
Miners Checks

We carry a large stock of checks in standard size (1⅜") as well as 1½" and 1¾" diam., in both **White Bronze and Brass.**

We can highly recommend the **White Bronze** as superior to the Brass in every particular. Send for sample and prices.

Mining Bit Boxes

These boxes are well made of heavy steel, 6½ iches wide; 6½ inches deep and 14 inches long.



Hinges are strong and box is provided with hasp for lock, and handle for carrying. Is painted bright red so that they are not readily lost in the coal.

Roofing

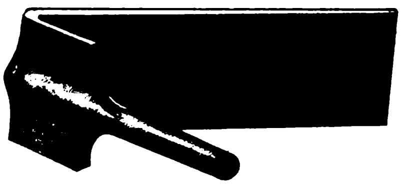
Turner Roofing is made of densely compressed long fibre wool felt and thoroughly saturated with Genuine Pure Trinidad Lake Asphalt and with a layer of Asphalt on both surfaces. This makes a lasting waterproof roofing which does not dry out, crack, or become brittle and break.

It is a non-conductor of heat, a non-conductor of sound, will not rust, is not affected by acids, alkalies, gases, fumes, vapors or sudden changes in temperature. It is made in three weights, 1, 2 and 3 ply, and put up in rolls containing 108 sq. ft.

In each roll is packed sufficient Kan-Leak Kleets with nails to apply.

The Kant-Leak Kleet is a dome-shaped galvanized plate which takes the place of large head nails or tin caps. It makes seams absolutely water tight, prevents bulging, completely does away with cement and gives a firm, even pressure along the seam, making the roof wind-proof and proof against rain, smoke or fumes driving under the surface.

Coke Scraper Heads
Full Weight.
Guaranteed.
17½ lbs. each.



TRANTER MANUFACTURING CO.

105 Water Street 104 First Avenue
PITTSBURGH, PA.

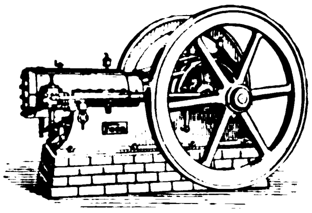
Machinists and Manufacturers

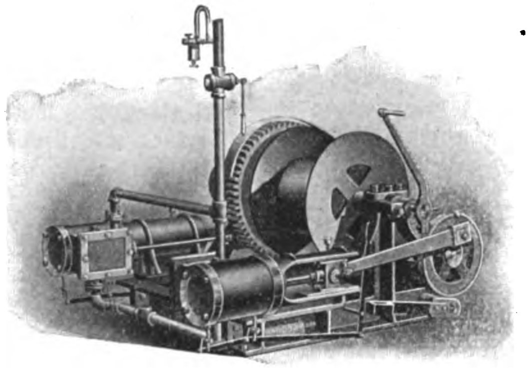
We have in stock and can furnish promptly the following:

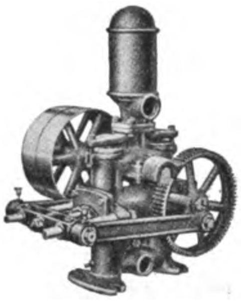
Air Compressors—"Tranter."
Air Tanks.
Boilers, Single Flue and Tubular.
Engines—Gas and Gasoline—"Foos".
Engines—Steam—"O. & S."
Ejectors and Jet Pumps.
Pumps—Steam and Power.
Pumps—"Gould". See pages 574, 575.
Pumping Machinery.
Centrifugal Pumps.
Hoisting Engines.
Electric Hoists.
Cold Rolled Steel Shafting.
Pulleys—(Iron, Wood and Steel).
Dynamos and Motors.
Storage Batteries.
Shaft Hangers.
Belting—Leather.
Belting—Rubber.
Belting—Canvas.
Pipe and Fittings.

OUR MACHINE SHOP

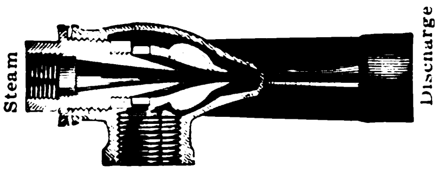
Covering 8000 square feet. Equipped with latest and most up-to-date Tools and Machinery, enables us to do all kinds of jobbing and repair work promptly and in first-class workmanlike manner.


Gas, Gasoline and Kerosene Engines, 1½ to 325 H. P.

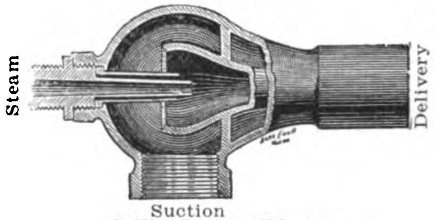

O. & S. Single and Double Cylinder Steam Hoisting Engines up to 45 H. P., and Gasoline Hoists to 40 H. P.


Power Pumps, all sizes, for Mine Work.

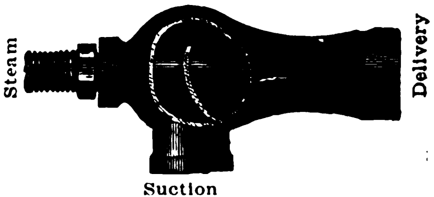
EJECTORS AND JET PUMPS



Suction
Coll's Patent "DEFIANCE" Pump



Suction
Coll's Patent Ejector



Suction
Sheriff's Patent Pump

Defiance Jet Pump

Is especially adapted for use in mines and deep wells where it is desired to elevate water or other liquids to high elevations. Warranted to elevate water 75 feet with 50 lbs. steam pressure, and by using two, one above the other, water can be elevated 100 feet—non-freezing.

Coll's Patent Ejector

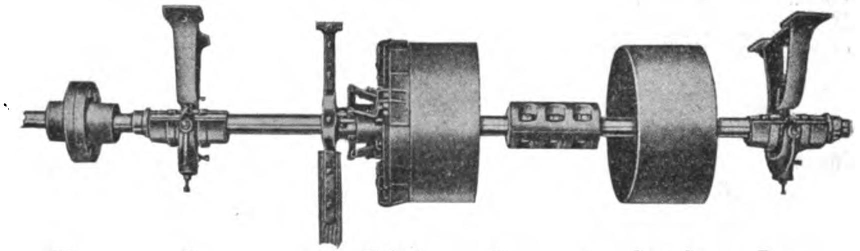
Is especially adapted for use on Steamboats, Steamships, Locomotives; by Mills, Mines, Factories, Tanneries, Breweries and Contractors. Will elevate water 35 feet. For pumping acids we make them of metal suitable for the purpose.

Sheriff's Patent Pump

Is extensively used in Salt Works, Breweries and Tanneries for handling brackish water, will elevate to a height not exceeding 35 feet, and is economical in the use of steam.

A FULL LINE OF TRANSMISSION MACHINERY CARRIED IN STOCK

Cold Rolled Steel Shafting.
Pulleys (Iron, Wood and Steel).
Solid and Split Shaft Collars.
Flange and Compression Couplings.
Steel and Cast Iron Drop Hangers.



SUBMIT US YOUR SPECIFICATIONS BEFORE PLACING YOUR ORDER

COLONIAL SUPPLY CO.

OFFICE AND SALES ROOMS

412-414 First Avenue

Bell Phones, 1043-1044 Court. P. & A., 1870 Main.

PITTSBURGH, PA.

Supplies for Ventilation

BRATTICE CLOTH

Brattice Cloth is too important a factor in Mining Operations to be neglected.

In buying Brattice Cloth get that which has **made good.** "Colonial", "Continental" or "Yankee".

Absolutely Non-Inflammable and Rot Proof.

Keep your requirements covered and prevent spreading of fires and loss of life from suffocation.

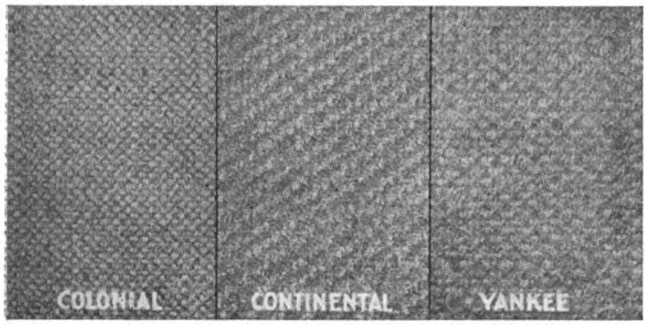
Quick restoration of temporary ventilation by means of Brattice Cloth saves property and life.

When you want Brattice Cloth you want it quick. Look into your stocks now and then order what you need of our thoroughly tested brands.

We are prepared to make prompt shipments, and rush them through, whether quantity ordered is carloads or less.

There is no use in having air in a mine unless it can be properly conducted to the working faces, and this can not be done if the airmen are not sufficiently supplied with Brattice Cloth.

We have always specialized in Brattice Cloth and want your business because we can give you the Quality and Service that satisfy.



Our "Colonial" Non - Inflammable Jute Duck Cloth, stronger than ordinary fabrics; the tight mesh of hard twisted yarns gives greatest durability. There is no better Brattice Cloth made.

Our "Continental" Non - Inflammable Brattice Cloth is a very close woven fabric, heavy, strong and durable, and when the yarns are swelled by mine dampness, this cloth is practically impervious to air.

Our "Yankee" Non - Inflammable Brattice Cloth is the lowest priced double-warped Jute Cloth. We never had a customer register a complaint against "Yankee" Brattice Cloth.

We keep the following widths in stock at all times:

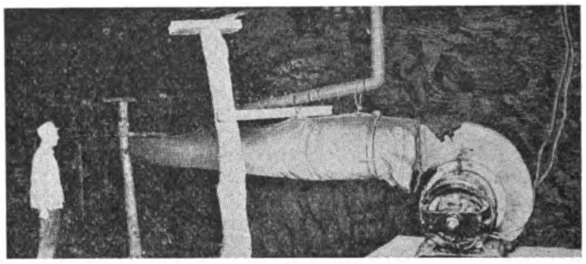
36 inch
42 inch
48 inch
60 inch
72 inch
84 inch
96 inch.

THE FLEXOID SYSTEM

FLEXOID tubing is a new system of ventilation in driving single entries—eliminating lost time after blasting.

The system consists of forcing air through a flexible air duct. It is made of a strong canvas treated with a preserving compound that effectively protects the fibres against the action of dry rot, weather exposure and acid water. The canvas is thoroughly saturated with the compound, then coated with a heavy preservative that makes the finished product airtight and waterproof.

It is suspended from a pipe or wire, or may be laid along the floor of the entry. It is carried near the face and unless the shots are very heavy, it is not affected. For heavy blasting, it is rolled back a few feet which provides ample protection against flying pieces.



The fans used with FLEXOID are small booster fans made by any of the standard fan companies. Any fan producing a static pressure up to 3" water gauge, depending on the volume and distance the air is required, will be satisfactory.

The principal use of the system in coal mines is the driving of single entries any distance practical with one blower.

Before FLEXOID tubing was placed on the market, it was impossible to do this. Practically the only available method was to use a line brattice which is successful for short distances only. For this work FLEXOID is so far superior to line brattices, there is no comparison.

In emergency work, driving air courses, cut offs, sinking shafts, clearing gases, gas pockets, FLEXOID is a great saver. It eliminates the necessity of parallel entries with double yardage. It also eliminates cross cuts, both their initial and upkeep cost. It provides a strong barrier pillar and presents an unbroken entry should an explosion occur.

The best way to determine the value of this new idea is to try the system fully at our risk.

It has proved such a great success whenever installed that we will ship to any responsible mine for sixty days trial several hundred feet of tubing. The operator is at liberty to put this to every test. If at the end of that time FLEXOID has not fulfilled all claims made for it—if it is not producing results, the tubing can be returned to us charges collect.

Take advantage of this offer—write for full particulars.

KEYSTONE CONSOLIDATED PUBLISHING COMPANY INC.

THE MINING CATALOG

MINERS' TOOLS & SUPPLY SECTION

The following manufacturers have catalogue descriptions in this section:

- Allison Coupon Co.
- Fulton Tool Co.
- Hardsocg Mfg. Co.
- Hardsocg, Martin, Co.
- Leetonia Tool Co.
- Nixon Mining Drill Co.
- Rand-McNally & Co.
- Southern Coupon Co.
- Warwood Tool Co.
- Wyoming Shovel Works, The.

For additional descriptions of Miners' Tools and Supplies, not appearing in this section, refer to Index of Products in front of book.

THE FULTON TOOL COMPANY

Established 1882
New Location
HUNTINGTON, WEST VIRGINIA
Formerly at Canal Fulton, Ohio
Re-organized 1916

Manufacturers of

THE FULTON LINE

Coal and Rock Drills, Breast Augers, Coal Picks; Wedges, Copper Tools, Machine Bits, Bit Steel, Spike Bars

Announcement

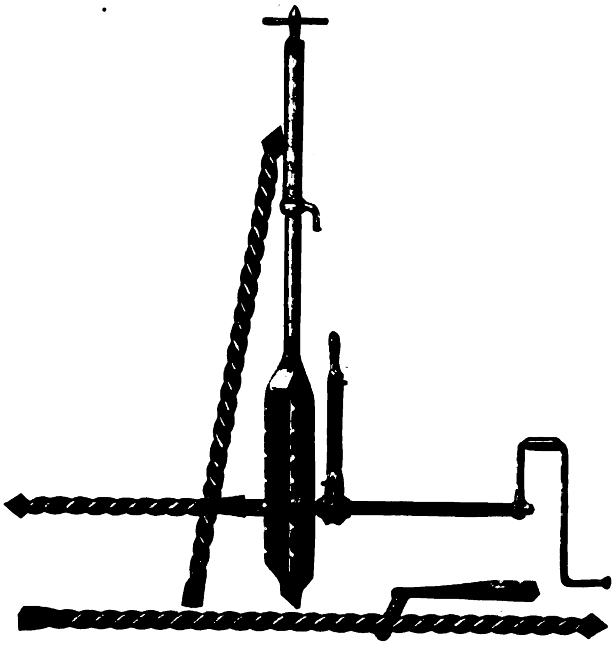
We are now in our new and modern plant at Huntington, W. Va., and are equipped to manfacture a larger and better quality line of miners' tools than heretofore.

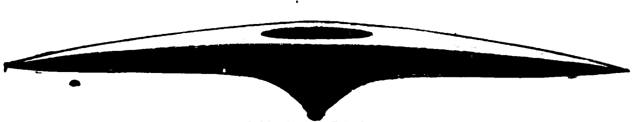
The "Fulton" line of tools is so well and favorably known that it is unnecessary for you to waste time and energy doing missionary work, endeavoring to introduce them, as they have already proven their worth to the users.

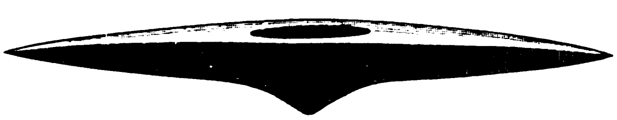
The paramount question with the user of the tools, is, what they do in actual and hard daily use. ASK THE MINER WHO USES THE TOOLS. HE IS THE BEST JUDGE. Stop the miner whom you see with a kit of tools, look for the brand and see the percentage that are stamped "Fulton," then ask him why so high a percentage of "Fulton" tools.

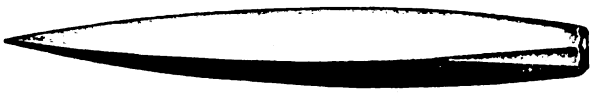
If you are unfortunate in that you have not had an opportunity to try the "Fulton" line of tools, order today and give the tools a thorough test. They will convince you, as they have many others, of their superior qualities.

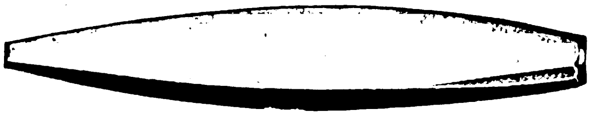
Your attention to the items illustrated below is especially invited as being worthy of your consideration when in the market. These are only a few of the many tools we manufacture:

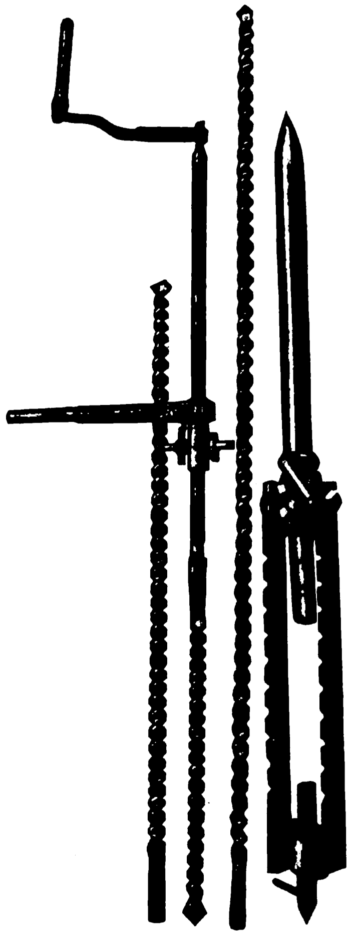

Eastern Pattern Rock Drill.

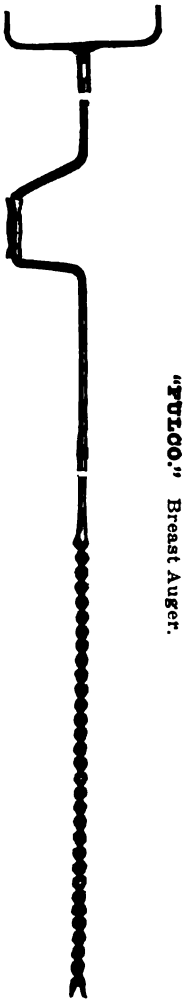

Mining Pick.


Cutting Pick.


Eastern Pattern Wedge.


Western Pattern Wedge.

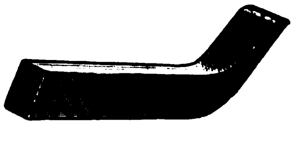

Western Pattern Rock Drill.


"FULCO." Breast Auger.

Bits and Bit Steel

Two qualities: **Crucible Grade and Special Analysis "Fulton" Grade.**

Sizes: ½" x ¾", ½" x ⅞" and ½" x 1".



THE LEETONIA TOOL COMPANY

LEETONIA, OHIO, U. S. A.

THIS L.T.Co. LEETONIA TO DEALER AND USER. ON TOOLS MEANS A GUARANTEE OF Quality

Manufacturers of

HIGH GRADE TOOLS

Coal and Rock Drills, Specialties

THIS L.T.Co. LEETONIA TO DEALER AND USER. ON TOOLS MEANS A GUARANTEE OF Quality

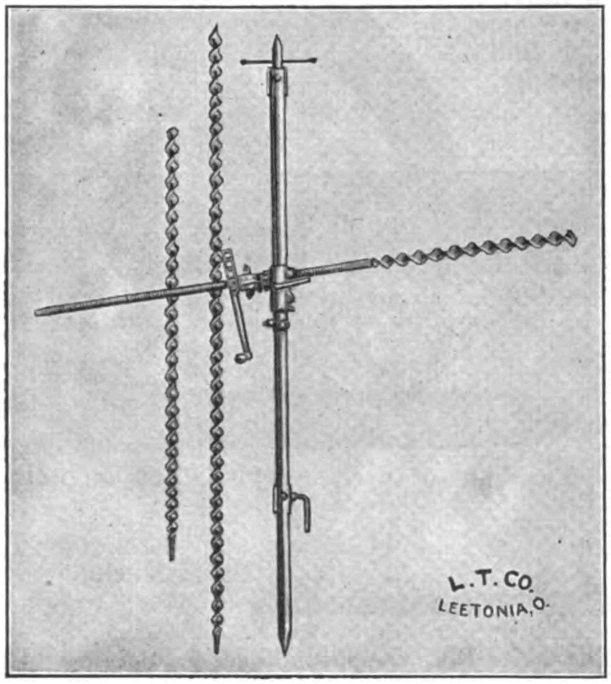
Products

Hand-operated Coal, Rock, and Plug Drills in Wood and Steel Post and Grip Bar types; Breast Augers; Coal Picks; Cleaner Picks; Sledges; Wedges; Steel and Copper Needles; Steel and Copper Tipped Tamp Drills; Steel and Copper Tipped Combined Tampers and Scrapers; Cold Chisels; Slate Bars; Jimmy Bars; Spike Bars; Pinch Bars; Machine Bits; Bit Steel; Rail Benders; Shovels; Mine Harps; Trolley Wheels; Oil Lamps; Carbide Lamps; Caps; Socket Wrenches; Complete Trackmens and Timbermens Outfits; Augers for electric power drills, etc. Our illustrated catalog free on request.

Drills

Our line consists of Hand-operated Drills in Wood and Steel Post and Grip Bar types, for drilling rock, coal, slate, or clay. All castings are made from the best malleable iron. All thread bars are made from 1⅛" special steel. Side-gear bars have double grooves which prevent the cog-wheel from twisting on the thread bar. The large cog-wheel has two solid keys cast in the wheel which make it rigid and cause it to run true. Bars are cut in the following threads: 6, 8 or 10 square, 6, 8, 10, 12 or 14 U. S. standard. Boxes, either side or end gear, are cut in any thread to fit the above bars but we recommend the square threads where 6, 8 or 10 can be used. All expert mechanical men claim this to be the proper thread for open nuts. Our new side gear box is constructed to withstand hard usage and for the easy removal and replacement of the threaded parts. We are prepared to thread boxings to fit 1 3-16" thread bars as follows: 6, 8 or 10 U. S. standard threads, and 6 or 8 Whitworth threads.

All our drills are now equipped with our recently patented Kant Lose Key Boxing.



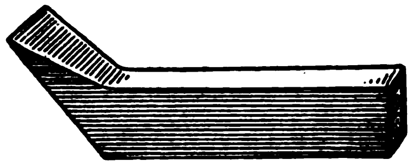
Augers

Augers are made from good auger steel in any lengths, with either split or diamond points. Augers made from oval-shaped steel can be furnished in the following sizes: 1¼, 1½, 1¾ and 2 inches. We also furnish augers made from 1½ by ½ inch oval steel with diamond point.

We recommend this auger for drilling hard rock and slate. All sizes of augers can be furnished in any length, but 2, 4 and 6 feet are the standard lengths.

Machine Bits

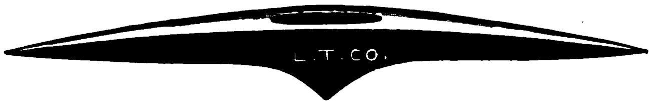
We can furnish Chisel and Pick Point Bits in sizes ½" by ¾", ½" by ⅞", and ½" by 1", in lengths of 4" to 4½". Our Bits will cut more tons of coal than any other bit made.



We have in stock for prompt shipment, the various sizes of Bit Steel, which we cut to any length.

Coal Picks

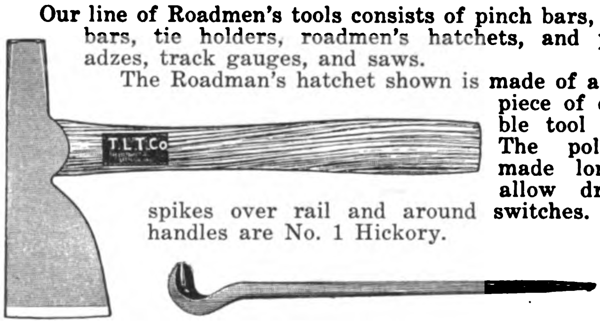
The eyes are large and have the proper shape to wedge securely to the handle. They are guaranteed to give satisfaction, and any proving defective in workmanship or material will be replaced or proper credit allowed. We carry picks in the following weights, 1½, 1¾, 2, 2¼, 2½, 2¾, 3, 3½, 4, 4½, and 5 pounds in all the common patterns. They can be supplied in the straight or anchored patterns.



Roadmens Tools

Our line of Roadmen's tools consists of pinch bars, spike bars, tie holders, roadmen's hatchets, and picks, adzes, track gauges, and saws.

The Roadman's hatchet shown is made of a solid piece of crucible tool steel. The pole is made long to allow driving spikes over rail and around switches. The handles are No. 1 Hickory.



The Bar also shown is our Goose Neck Spike Bar. This is an efficient tool and a time saver. Note the heavy heel for driving under spike.

THE MARTIN HARDSOCG CO.

PITTSBURGH, PA.

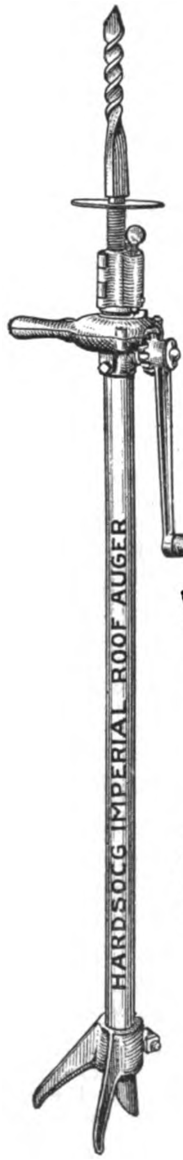
HARDSOCG MFG. CO.

OTTUMWA, IOWA
Main Office and Works
Branch:
EVANSVILLE, IND.

In addition to the items illustrated below, which are especially designed for the personal use of coal companies in their own work, and some of which are new to many mine managers, we make every tool used by the coal miner. We cater especially to quality, and with nearly 40 years experience should be able to serve you with intelligence. We can make any tool you need.

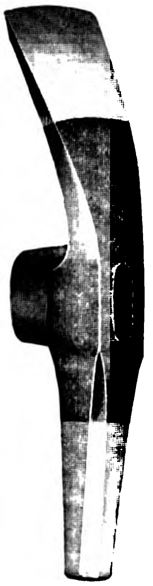
CAUTION. Some concerns are using names of our goods and illustrations, to advertise imitations of our products,—cuts being copied from our catalog. Genuine Hardsocg Products are made only by us and all parts interchange perfectly, usually the imitations do not interchange and are often worthless. Insist on the genuine.

"Imperial" Automatic Feed Roof Auger, Patented.



This drill is especially designed for boring holes for insulator pegs.

It adjusts itself automatically to hard or soft drilling by means of our patent feed feature, having the effect of any thread from the coarsest for fast work to the finest for hard rock—**on the same thread bar.** Being adjustable in height with reversible thread bar and quite light it is strictly **a one man drill** and is absolutely guaranteed to do your work or **your money back.**

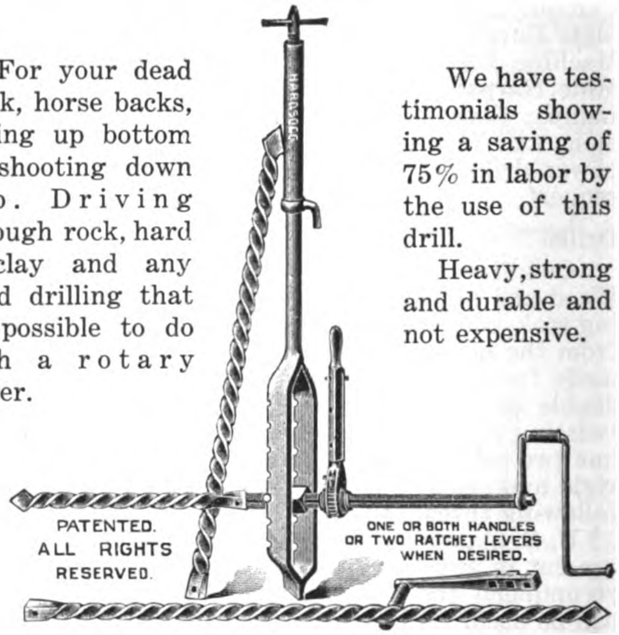


Hardsocg Track Adze

A new tool. Original with us.

YOU NEED IT.

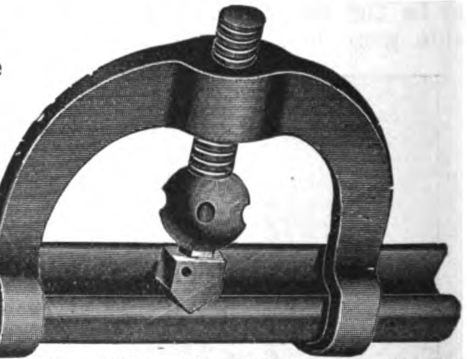
Hardsocg Rock Ratchet Drill, Eastern Pattern.


HARDSOCG
PATENTED. ALL RIGHTS RESERVED.
ONE OR BOTH HANDLES OR TWO RATCHET LEVERS WHEN DESIRED.

For your dead work, horse backs, taking up bottom or shooting down top. Driving through rock, hard fireclay and any hard drilling that is possible to do with a rotary auger.

We have testimonials showing a saving of 75% in labor by the use of this drill.

Heavy, strong and durable and not expensive.

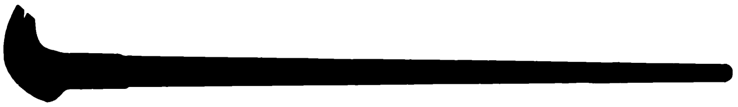


New Reversible Screw Single Acting Rail Bender

Coke Pulleys, Lifting Jacks, Air Drills, "Atlas" Car Movers. Better prices on same quality. Better quality at same prices on "HARDSOCG" goods.

We make more Bits and Punchers of every pattern than any other concern in the world. Get Prices.

Costs Little

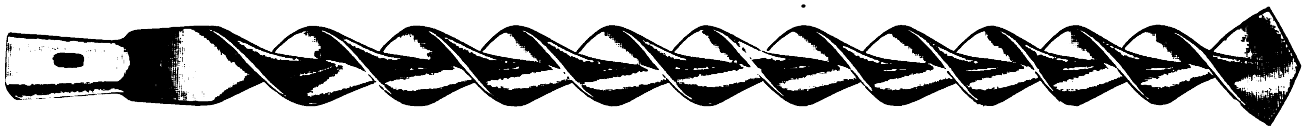


Saves Much Labor

This is Hardsocg's New "Imperial" Tracklayers Spike Bar. Note the special heel for driving under spike. It is a wonder.

HARDSOCG PRODUCTS---Continued

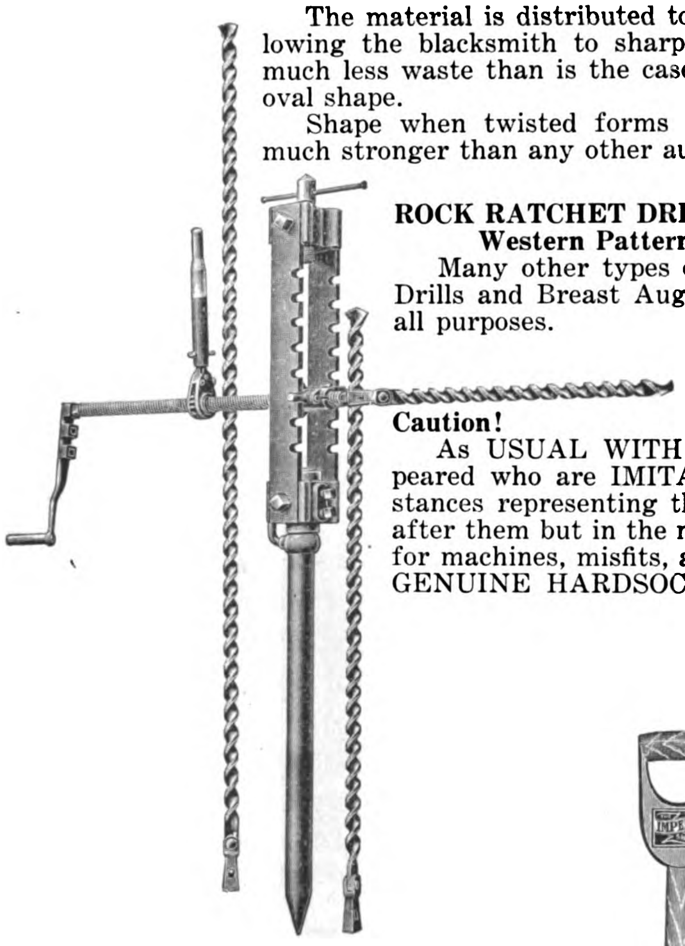
A NEW SHAPE AUGER



Look For the Name—HARDSOCG-PREMIER-PAT'D.—Rolled In the Steel.

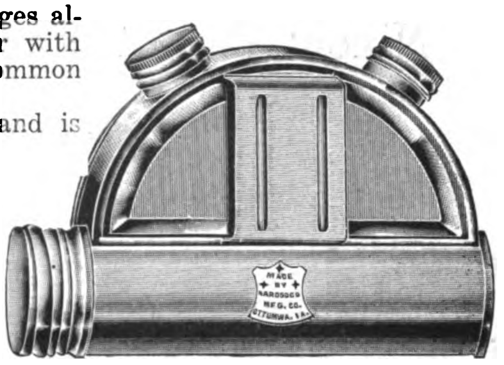
The material is distributed toward the edges allowing the blacksmith to sharpen the auger with much less waste than is the case with the common oval shape.

Shape when twisted forms a conveyor and is much stronger than any other auger.



ROCK RATCHET DRILL
Western Pattern

Many other types of Coal Drills and Breast Augers for all purposes.


MADE BY HARDSOCG MFG. CO. OTTUMWA, IA.

Patent Compartment Canteen for Carbide, Water and Matches.

Caution!

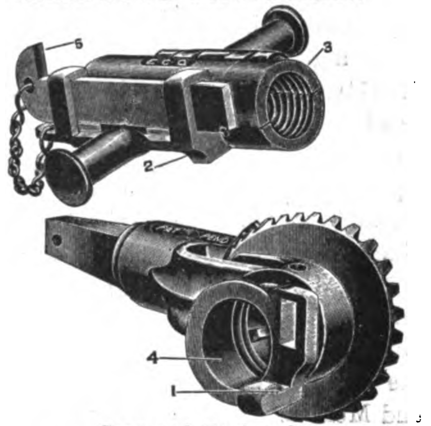
As USUAL WITH ALL GOOD THINGS some PIRATES have appeared who are IMITATING HARDSOCG GOODS and are in some instances representing them to be HARDSOCG products. We are going after them but in the meantime if you want to save confusion in repairs for machines, misfits, and dissatisfaction of your customers generally, buy GENUINE HARDSOCG goods from the HARDSOCG FACTORIES.

No. 5 Western Pattern

This is our No. 5 cap provided

with a receptacle for matches. This receptacle is lined inside with cloth to prevent matches falling out. Matches are kept perfectly dry. A most convenient and attractive cap.

Hardsocg "Premier" and "Imperial" (Trade Mark Reg.) Brands. Finest polished shovel made.



Gear and Boxing for
OUR BEST COAL DRILL
E C "Q
Easy Cutting "Q"

E C "Q" Coal Drill

Uses regular post (Post not shown).

Combines all the good features of our old "Q" Machine with several important improvements. Large Size Gear Wheel, no lost motion and Double Slot Thread Bar; make this the easiest running Coal Drill on the market.

Refering To the Above Cuts

1. Hook which engages lug on boxing.
2. Lug which fits into hook on gear frame.
3. Turned end of boxing which fits in recess in gear frame.
4. Recess in gear frame which receives end of boxing.
5. Key which locks boxing and gear together.

NIXON MINING DRILL COMPANY

MANUFACTURES OF

Nixon Patent Rachet Mining Drills and Supports.

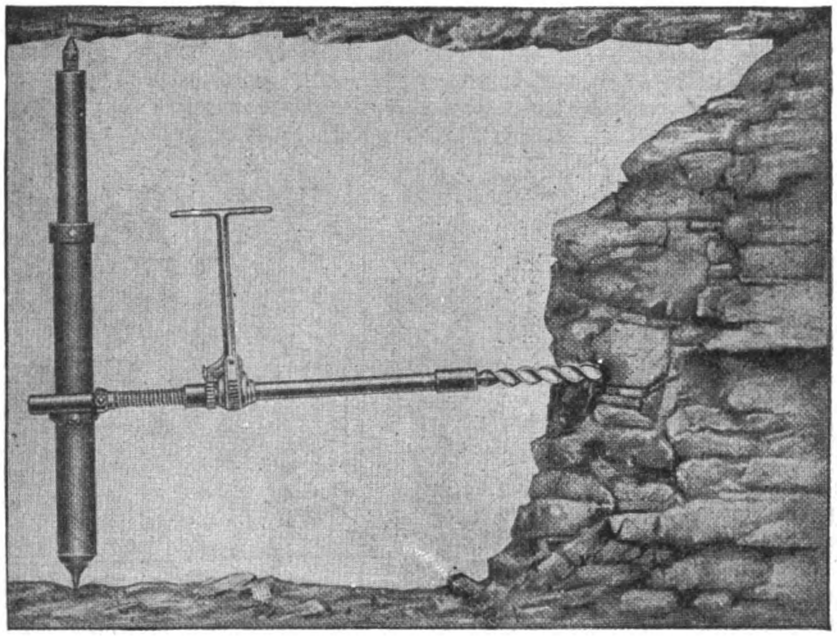
Office and Works--Chattanooga, Tenn

Products

Manufacturers' Drills, Supports for Boring Coal, Iron Ore, Slate, Stone, etc.

Automatic Feed

Automatic Feed, faster or slower, as material bored is soft or hard, ranging from 0 to 2½ turns per inch. Strong, simple, durable, economical — requiring but one man to operate, and works in any close place. Established in 1888. Favorably known in every mining camp in the United States and Mexico.



This illustration represents a Nixon Patent Rachet Mining Drill and Support set up in a Rock Entry.

Cheapness in Operation

As a general proposition holes can be bored per foot, all costs considered, cheaper with **Nixon Ratchet Mining Drills** than with any other machine, hand or power. In mines already equipped with power it is frequently profitable to drive isolated or outlying entries or workings with **Nixon Drills.**

Special Features

The **Nixon** has eight inches differential in set up of post, which no other drill has. All large mine supply houses handle **Nixon Ratchet Mining Drills** and supports. All **Nixon Drills** and parts are now branded with trade mark.

For Driving Entries

Mining hard coal, iron ore, slate, etc., or taking top or bottom in coal or ore mines, it is the best drill in the world. Bores rock, slate and ore no other ratchet drill will bore. And any material that others will, the **Nixon Ratchet** bores faster and easier.

Get prices from dealers or commissary and accept nothing but the genuine **Nixon Drill.** Unscrupulous people are offering imitations made of inferior materials and workmanship.

For Boring Coal, Iron Ore, Slate, Stone, Etc.

Price of Drill only (either No. 1 or Patent Feed (P. F.)	$21.00
Support, under 5 feet	5.00
Set of Three Bits	5.00
One Drill complete	$31.00

Liberal discounts allowed purchasing agents and commissary storekeepers.

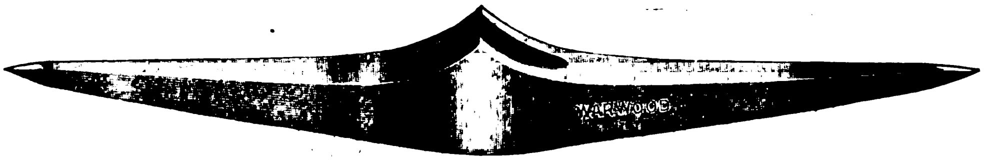
WARWOOD TOOL COMPANY

WARWOOD WHEELING, W. VA.

Manufacturers of

The Celebrated Warwood Coal Pick

Started in 1854 Incorporated 1892



WARWOOD COAL DRILLS

New Department, Manufacturing Coal Drilling Machines and Parts

Warwood New Improved Lever Boxing

Used in these Machines, and furnished on repair orders is convenient, durable and secure, and a distinct improvement over old styles.

Warwood Corrugated Steel Post Drill

This drill is fitted with No. 55 Thread Bar and No. 131-C New Improved Lever Boxing. Made in two patterns, side and end gear, also in the Grip pattern. All parts interchangeable with similar drills now in use.

Warwood Joplin Post and Grip Drills

Side bars of post drill are made of high carbon channel steel. Very strong, but light. Fitted with the Joplin No. 2 New Improved Lever Boxing.

Warwood L Steel Post Drill

A light end gear machine. Fitted with the Improved Lever Boxing. All parts interchangeable with similar drills in use.

Warwood Repair Parts

For Drills now in use will interchange and contain latest improvements in pattern and workmanship.

SPECIALTIES

Coal Picks, Miner's Augers, Hand or Churn Drills, Miner's Tamper with Scraper, Miner's Scraper, Miner's Needles, Miner's Copper Tamp Drills and Scraper, Miner's Copper Needles, Coal Miner's Pinch or Lifting Bar, Mine Spike Claw Bar, Coal Wedges, Warwood Guaranteed Machine Puncher Picks, Unfinished Machine Bit Blanks, all kinds, Coal Sledges, Coal Drilling Machines and parts, etc.

THE WYOMING SHOVEL WORKS

WYOMING, PENNA. U. S. A.

Manufacturers of

Wyoming Red Edge Shovels

Products

We manufacture all standard patterns and sizes of shovels in our Red Edge grade. Pettebone Back Strap, Hollow Back, Plain Back; Square and Round Point; Long and D Handle.

Construction

Wyoming-Mayari Red Edge Shovels are made of Mayari Chrome Nickel Steel, from a natural alloy ore with certain well defined chromium and nickel content, particularly adapted for shovel blades.

The blades are heat treated all over, during which treatment they are tested by the Brinell process to a point that indicates the greatest possible resistance to abrasion.

The handles are reselected from selected XX Northern White Ash and are made in our own handle factory.

The finished shovel is given a "rough and ready" test in a special device, after which it is placed in a standard handle testing machine and subjected to a load of 350 pounds.

"Three-Lives-In-One" Shovel

Wyoming-Mayari Red Edge Shovels are made so wear-proof that they outlive in usefulness more than two shovels of the best of other makes on the market, and any number of the cheaper grades.

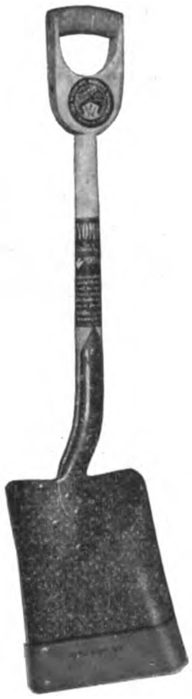
The issue can be dodged a dozen different ways, but in these days of maximum production and unusual labor conditions, there is only one way to meet it. Equip with Red Edge Shovels.

Guarantee

Wyoming-Mayari Red Edge Shovels are guaranteed to be perfectly satisfactory in every respect—under every condition of service—or we will make whatever adjustment the buyer may decide is right and proper, without hesitation or objection.

Cost

Notwithstanding the above, and furthermore, taking into consideration the fact that the steel we use costs more, the heat treatment of each shovel is an additional expense, Wyoming Red Edge shovels are sold at only a nominal advance over the price of crucible steel shovels.



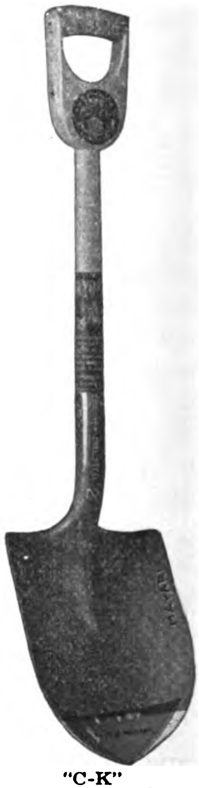
B. J. Pettebone
Back Strap.

Square Point Shovel Sizes

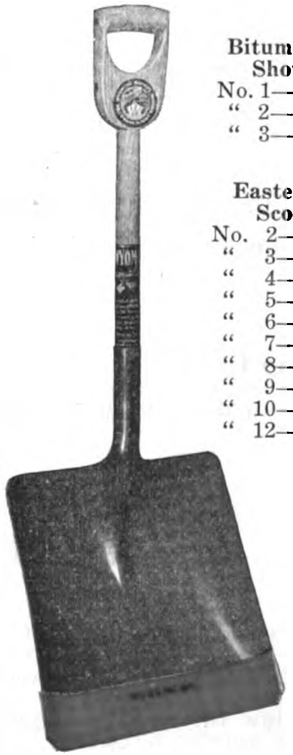
No. 2— 9⅞ x 11⅞
" 3—10¼ x 12½
" 4—10⅞ x 12¾
" 5—11⅜ x 13¼
" 6—11¾ x 13¾

Round Point Shovel Sizes

No. 2— 9⅞ x 12⅞
" 3—10¼ x 13½
" 4—10⅞ x 13¾
" 5—11⅜ x 14¼
" 6—11¾ x 14¾



"C-K"
Hollow Back.



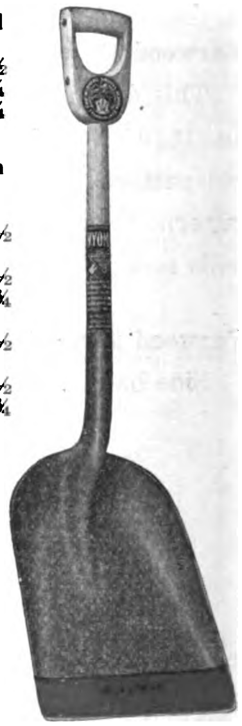
Bituminous Coal Shovel.

Bituminous Coal Shovel Sizes

No. 1—13¼ x 13½
" 2—14 x 14¼
" 3—14½ x 14¾

Eastern Pattern Scoop Sizes

No. 2—11¼ x 15
" 3—11½ x 15½
" 4—11¾ x 16
" 5—12⅜ x 16½
" 6—12⅞ x 16¾
" 7—13⅜ x 17
" 8—13¾ x 17½
" 9—14½ x 18
" 10—15⅛ x 18½
" 12—15¾ x 19¾



Eastern Pattern Scoop.

ALLISON COUPON CO.

INDIANAPOLIS, IND.

Manufacturers of

Allison Improved Coupon Books

For Use In "Company" Stores, Ice Companies, Theatres,. Restaurants, Dairies, Clubs, Garages, Laundries, Water Companies Etc

Products

More than a quarter century ago, the Allison Coupon Company originated the coupon system for company stores, and thereby, simplified accounting and the handling of sales. These long years of experience in the manufacture of coupon books for home and foreign mines and the especially perfected machinery and methods the company adopts, enables it to place on the market a product unsurpassed, original in design, beautiful in appearance and absolutely accurate. The business of this company and the demand for these books is evidenced by the fact that the Allison plant is now the largest of its kind in the world devoted exclusively to the manufacture of Coupon Books.

In these days it is not necessary to explain in detail the use of coupon books to the store manager, —He knows.—He knows that these books save time because every moment of time spent in many entries, making itemized lists of each sale, and filing duplicates is saved by their use. He knows that his clerks can attend to more customers and do so more accurately with coupons. He knows that he has a record in the store for every sale; that he has no arguments with his customers; and everybody is pleased. He has proven to his entire satisfaction that he has saved time and money and prevented errors and loss.

These books are made in several sizes and in different designs. In fact designs are specially made to suit the company in following its general distinctive form of stationery. The materials used are especially made for the Allison Coupon Company, watermarked, and specially colored thus safeguarding the product against counterfeiting, and other manipulations. The cuts here shown illustrate two sizes and styles of books and coupons. The company issues annually a beautifully illustrated and descriptive catalog showing many different designs and full explanation in regard to their uses. This catalog together with samples are mailed free upon request.

If this company has one "hobby" over another, that "hobby" is **accuracy and service.** Supreme accuracy has carried the process to such a point that mistakes in numbering and count are practically impossible. Service to the point of thousands of satisfied customers. Its supreme "hobby" is **Perfection.** It does not seek its customers on the theory of their dissatisfaction with other systems, but because of its own superior advantages.

Prompt and courteous attention is strictly paid to all inquiries.

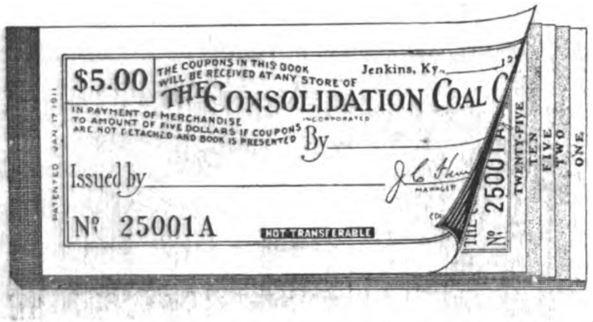
RAND McNALLY & COMPANY

CHICAGO NEW YORK

Manufacturers of

Patented Self-Indicating Coupon Books for Commissaries

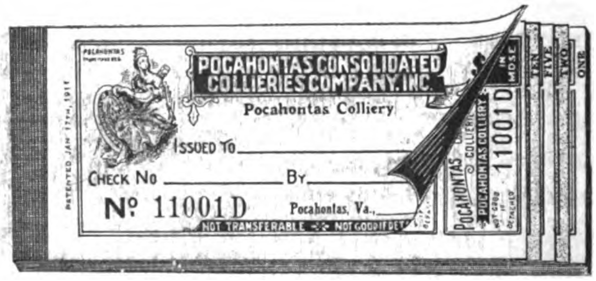
The Coupon Book System of keeping store accounts with employees is becoming more and more general in the Coal Mining business. No other invention provides such a simple and perfect check upon small transactions, or so effectually stops the leaks possible where a separate charge is necessary for each purchase.


$5.00
THE COUPONS IN THIS BOOK WILL BE RECEIVED AT ANY STORE OF
Jenkins, Ky.
THE CONSOLIDATION COAL C
IN PAYMENT OF MERCHANDISE TO AMOUNT OF FIVE DOLLARS IF COUPONS ARE NOT DETACHED AND BOOK IS PRESENTED
By
Issued by
Nº 25001A
NOT TRANSFERABLE
TWENTY-FIVE
TEN
FIVE
TWO
ONE

The Commissary Manager issues the book and takes a receipt which he turns over to the Paymaster with instructions to deduct the face value from the next pay check issued to the purchaser of the book.

The Coupon Books simplify the work of the book-keeper. Instead of an entry for each purchase, however small, the posting is reduced to one entry for each book issued. By this method there is practically no opportunity for dispute regarding an account, for the reason that when an employee presents his coupon book, he knows how many coupons are in it, he sees what are taken out in exchange for his purchase and still has his book for a more deliberate examination if he is so inclined.

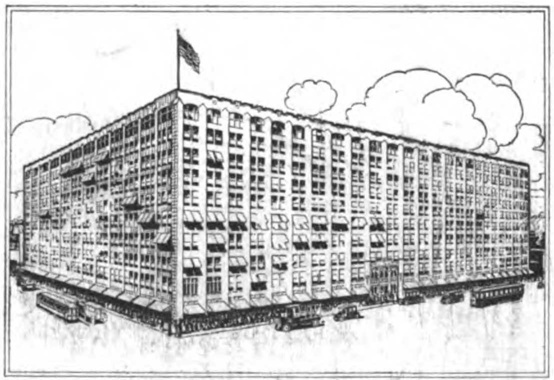
There are various Coupon Books, but the Patented Self-Indicating Coupon Books excel because of their simplicty.



It will be noted, by consulting the above illustrations, that each denomination is indexed at the bottom of its page. This feature aids materially in the detachment of any denomination without the necessity of turning a number of pages. It is considered the very best Coupon Book on the market.

If you are using Coupon Books, are you entirely satisfied with the goods, the service, etc., you are now paying for? If not, we shall be very glad to have an opportunity of introducing the "Rand McNally Service."

We have special representatives, calling on the Coal Mining Commissaries at regular intervals, who are well acquainted with the merits of the Coupon System, and who can give any information desired in regard to installing this method. Prompt attention will be given to an inquiry in this direction.



Rand McNally Printing House
Clark & Harrison Sts., Chicago

Send for Samples and Prices.

SOUTHERN COUPON COMPANY

Office and Factory

BIRMINGHAM, ALA.

Exclusive Manufacturers of COUPON BOOKS of Every Description

Products

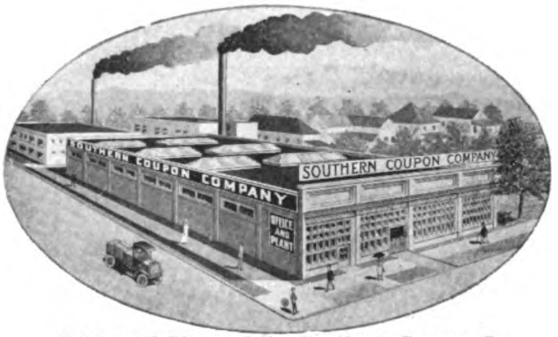
The Southern Coupon Company confines itself exclusively to the manufacture of Coupon Books of every description, such as Mercantile, Ice, Laundry, Meal, Dairy, Street Railway, Automobile Supply, Club, and many other books, and with its large, modern plant and complete, up-to-date, automatic equipment is in position to handle all orders promptly at minimum cost, and to guarantee absolute accuracy. Its product is printed in all modern languages and its market reaches the four corners of the world.

The Coupon System

The coupon system has long since passed the experimental stage and has proved most effective in satisfactorily discharging obligations between the company and its employees. The Southern Coupon System reduces the complicated bookkeeping associated with the lose check and card "punch-outs" to a minimum, and, at the same time, eliminates much of the red tape connected therewith. It is a safe method for the company and a simple method for the employees. The Southern Coupon System makes bookkeeping unnecessary, the accounts being kept automatically, while it presents no intricacies to bewilder the employee in his transactions with the company.

Advantages

Coupon books have many advantages but to the business man the saving of time and money affected by their use possibly appeal the most. The multitudinous petty transactions which involve exhaustive bookkeeping, creating possibilities for errors, which often cannot be traced, are taken care of by an automatic, self-regulating system, the simplicity of which protects the most careless employee from mistakes, and prevents disputes, because it can be grasped by the most ignorant patron.



Office and Plant of the Southern Coupon Co.

Perfect Checking Upon All Transactions

The Southern Coupon System provides a perfect check upon small cash or charge transactions and makes impossible the leaks and losses to which such transactions are susceptible in a more effective manner than can be accomplished by any other method. Until the coupon book is issued, properly countersigned, it is valueless and, even then, if lost or stolen, worthless.

Dishonesty or carelessness cannot creep in, as each book issued must be accounted for by cash, note or receipt covering its full value. At any moment, in a relatively short time, an audit may be made merely by comparing receipts for books issued with those on hand.

The coupons are worthless unless presented in the original book of which they form a part and the owner of the book is concerned only in obtaining the full exchange to which he is entitled when surrendering the coupons. There is no incentive to retain or lose coupons surrendered in this manner, as they are of no value either to the clerk who takes them or to any other person who may become possessed of them. The absence of coupons will affect the total sales for the day, therefore, particular care is taken to see that they go into the cash drawer or any other receptacle designed for the purpose. No actual loss is incurred even should the coupons be missing.

Further information, samples and prices cheerfully furnished to anyone interested, on application.

The person charging this material is responsible for its return on or before the **Latest Date** stamped below.

Theft, mutilation, and underlining of books are reasons for disciplinary action and may result in dismissal from the University.

UNIVERSITY OF ILLINOIS LIBRARY AT URBANA-CHAMPAIGN

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